

Standards Committee Meeting Agenda

THURSDAY, SEPTEMBER 15, 2016

9:00 A. M. to 12:00 noon

1801 W. Jefferson, Copper Conference Room

INTRODUCTIONS:

All

NEW REQUESTS

16-0022: Standard Specification 608

Jon Adams, Avery Dennison

16-0023: Materials Testing Manual, Series 1000, Figure 2

Craig Wilson. ADOT

STATUS OF APPROVED REQUESTS

Committee Members

16-0001: Stored Specification 109, Sections 415-417

16-0002: Arizona Test Method 236d

16-0003: Policy and Procedures Directive Manual, PPD 16

16-0006: Arizona Test Method 212f

16-0007: Arizona Test Method 210c

16-0009 Arizona Test Method 318a

OTHER BUSINESS

Committee Members

ADJOURN:

All

NEXT MEETING: Thursday, October 20, 2016

Supporting documentation is posted on the Standards Committee web page at
<http://www.azdot.gov/business/standards-and-guidelines/standards-committee>





STANDARDS COMMITTEE REQUEST FORM

TRACKING# 116-0022
Coordinator assigns tracking # to request upon receiving.

DATE OF REQUEST: August 19, 2016

REQUESTOR'S ORGANIZATION: Avery Dennison Corporation

(If Internal to ADOT, include District/Group Name)

REQUESTOR: Moe Madar

PHONE: (312) 543-0907

EMAIL: moe.madar@averydennison.com

PRIORITY LEVEL:



High



Medium



Low

DESCRIPTION OF REQUEST:

Enter description of action being requested. Include type of action (new or revision) and provide document name, title, and section. If additional information is needed, please attach a separate document. Explain why request is a high, medium, or low priority.

This is a new and high priority request to revise the 608 PANEL, dated 01/26/2016, section 608-2.16.

This is a high priority request because the current version of the specification is unnecessarily restrictive, and limits the use of our system. The restrictive requirements have had major negative impacts for us, and our local Arizona sign fabricator partners.

Avery Dennison would like to respectfully request for ADOT to align the 608 PANEL specification with other sign component requirements, and allow sheeting manufacturers to recommend the best system for sign fabrication. Alternatively, ADOT may revise PANEL 608 to include eco-solvent spot inks as an allowed ink technology.

REASON FOR REQUEST:

Enter a detailed description of why the action is being requested.

Digital printing of traffic signs is the latest method of sign fabrication. Avery Dennison is proud to supply the most widely approved systems available in the market: the TrafficJet Print System. The TrafficJet Print System is an Avery Dennison warranted component, required for digital printing on Avery Dennison retroreflective sheeting. Unfortunately, in the case of digital printing, ADOT has limited the ink technologies to "ultraviolet jet-printing or thermal transfer", which restricts the use of eco-solvent spot inks, necessary for our system and warranties.

LIST ALL SUPPORTING DOCUMENTATION THAT IS BEING SUBMITTED WITH THIS REQUEST:

- 1) Independent test data, showing the TrafficJet Print System meets ASTM D4956 and ADOT requirements for sign performance.
- 2) Durability test reports from Kansas DOT.
- 3) A case study detailing how CO DOT uses the TrafficJet Print System.
- 4) Approval letter from Texas DOT.

Submit completed form and all supporting documentation to Lisa Sinclair, ADOT Standards Committee Coordinator at lsinclair@azdot.gov.

KANSAS DEPARTMENT OF TRANSPORTATION

Report of sample of Image Systems for Retroreflective Sheeting, Type IV

Laboratory No. 15-2103
Date Rep'td. 03-25-16
Date Rec'd. 07-30-15

Specification No.	<u>15-22005</u>	Quantity	<u>Mfg. Sample</u>
Source of material	<u>Avery Dennison, Graphic and Reflective Films Division</u>		
Sample from	<u>7542 N. Natchez Ave., Niles, IL 60714</u>		
Submitted by	<u>Moe Madar</u>		
Identification marks	<u>Black Traffic Jet</u>		
Project or POV	<u>Prequalification</u>		
Type construction	<u></u>		
Contractor	<u></u>		

TEST RESULTS

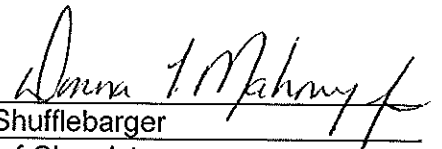
Appearance	OK
Color	OK
Adhesion, inches	0.2
Shrinkage	OK
Accelerated Weathering	Passes

This material complies with specification requirements.

c: K. Shufflebarger
Avery Dennison – M. Madar
File

Reported by

Title


K. Shufflebarger
Chief Chemist

KANSAS DEPARTMENT OF TRANSPORTATION

Report of sample of Image Systems for Retroreflective Sheeting, Type IV

Laboratory No. 15-2104
Date Rep'td. 03-25-16
Date Rec'd. 07-30-15

Specification No.	15-22005	Quantity	Mfg. Sample
Source of material	Avery Dennison, Graphic and Reflective Films Division		
Sample from	7542 N. Natchez Ave., Niles, IL 60714		
Submitted by	Moe Madar		
Identification marks	Black Traffic Jet + OL-2000		
Project or POV	Prequalification		
Type construction			
Contractor			

TEST RESULTS

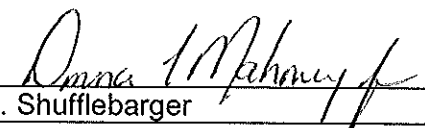
Appearance	OK
Color	OK
Adhesion, inches	0.2
Shrinkage	OK
Accelerated Weathering	Passes

This material complies with specification requirements.

c: K. Shufflebarger
Avery Dennison – M. Madar
File

Reported by

Title


K. Shufflebarger
Chief Chemist

dln

KANSAS DEPARTMENT OF TRANSPORTATION

Report of sample of Image Systems for Retroreflective Sheeting, Type IV

Laboratory No. 15-2105
Date Rep'td. 03-25-16
Date Rec'd. 07-30-15

Specification No.	15-22005	Quantity	Mfg. Sample
Source of material	Avery Dennison, Graphic and Reflective Films Division		
Sample from	7542 N. Natchez Ave., Niles, IL 60714		
Submitted by	Moe Madar		
Identification marks	TJ01 Yellow +OL-2000		
Project or POV	Prequalification		
Type construction			
Contractor			

TEST RESULTS

Appearance OK
Color OK
Adhesion, inches 0.2
Shrinkage OK
Accelerated Weathering Passes
Reflective Intensity

Angle of Incidence

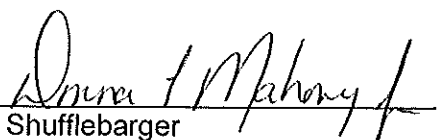
		-4°	30°
Divergence	0.2°	361.5	154.0
Angle	0.5°	283.0	77.5

This material complies with specification requirements.

c: K. Shufflebarger
Avery Dennison – M. Madar
File

Reported by

Title


K. Shufflebarger
Chief Chemist

KANSAS DEPARTMENT OF TRANSPORTATION

Report of sample of Image Systems for Retroreflective Sheeting, Type IV

Laboratory No. 15-2108
 Date Rep'td. 03-25-16
 Date Rec'd. 07-30-15

Specification No.	15-22005	Quantity	Mfg. Sample
Source of material	Avery Dennison, Graphic and Reflective Films Division		
Sample from	7542 N. Natchez Ave., Niles, IL 60714		
Submitted by	Moe Madar		
Identification marks	TJ05 Blue + OL-2000		
Project or POV	Prequalification		
Type construction			
Contractor			

TEST RESULTS

Appearance	OK
Color	OK
Adhesion, inches	0.2
Shrinkage	OK
Accelerated Weathering	Passes
Reflective Intensity	

Angle of Incidence


		-4°	30°
Divergence	0.2°	61.4	29.3
Angle	0.5°	51.0	12.7

This material complies with specification requirements.

c: K. Shufflebarger
 Avery Dennison – M. Madar
 File

Reported by

Title


 K. Shufflebarger
 Chief Chemist

KANSAS DEPARTMENT OF TRANSPORTATION

Report of sample of Image Systems for Retroreflective Sheeting, Type IV

Laboratory No. 15-2107
Date Rep'td. 03-25-16
Date Rec'd. 07-30-15

Specification No.	<u>15-22005</u>	Quantity	<u>Mfg. Sample</u>
Source of material	<u>Avery Dennison, Graphic and Reflective Films Division</u>		
Sample from	<u>7542 N. Natchez Ave., Niles, IL 60714</u>		
Submitted by	<u>Moe Madar</u>		
Identification marks	<u>TJ07 Green + OL-2000</u>		
Project or POV	<u>Prequalification</u>		
Type construction	<u></u>		
Contractor	<u></u>		

TEST RESULTS

Appearance	OK
Color	OK
Adhesion, inches	0.3
Shrinkage	OK
Accelerated Weathering	Passes
Reflective Intensity	

Angle of Incidence

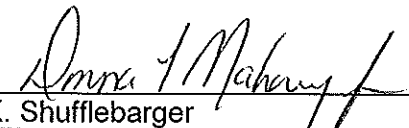
		-4°	30°
Divergence	0.2°	98.7	41.8
Angle	0.5°	84.0	19.9

This material complies with specification requirements.

c: K. Shufflebarger
Avery Dennison – M. Madar
File

Reported by

Title


K. Shufflebarger
Chief Chemist

KANSAS DEPARTMENT OF TRANSPORTATION

Report of sample of Image Systems for Retroreflective Sheeting, Type IV

Laboratory No. 15-2106
 Date Rep'td. 03-25-16
 Date Rec'd. 07-30-15

Specification No.	15-22005	Quantity	Mfg. Sample
Source of material	Avery Dennison, Graphic and Reflective Films Division		
Sample from	7542 N. Natchez Ave., Niles, IL 60714		
Submitted by	Moe Madar		
Identification marks	TJ08 Red + OL-2000		
Project or POV	Prequalification		
Type construction			
Contractor			

TEST RESULTS

Appearance	OK
Color	OK
Adhesion, inches	0.2
Shrinkage	OK
Accelerated Weathering	Passes
Reflective Intensity	

Angle of Incidence

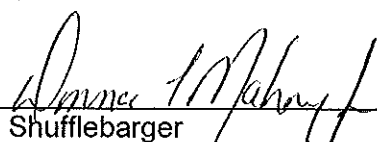
		-4°	30°
Divergence	0.2°	113.0	49.9
Angle	0.5°	82.4	25.2

This material complies with specification requirements.

c: K. Shufflebarger
 Avery Dennison – M. Madar
 File

Reported by

Title


 K. Shufflebarger
 Chief Chemist

KANSAS DEPARTMENT OF TRANSPORTATION

Report of sample of Image Systems for Retroreflective Sheeting, Type IV

Laboratory No. 15-2109
Date Rep'td. 03-25-16
Date Rec'd. 07-30-15

Specification No.	15-22005	Quantity	Mfg. Sample
Source of material	Avery Dennison, Graphic and Reflective Films Division		
Sample from	7542 N. Natchez Ave., Niles, IL 60714		
Submitted by	Moe Madar		
Identification marks	TJ09 Brown + OL-2000		
Project or POV	Prequalification		
Type construction			
Contractor			

TEST RESULTS

Appearance	OK
Color	OK
Adhesion, inches	0.2
Shrinkage	OK
Accelerated Weathering	Passes
Reflective Intensity	

Angle of Incidence

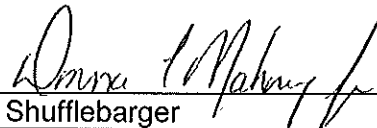
		-4°	30°
Divergence	0.2°	45.3	18.9
Angle	0.5°	36.7	9.3

This material complies with specification requirements.

c: K. Shufflebarger
Avery Dennison – M. Madar
File

Reported by

Title


K. Shufflebarger
Chief Chemist

Colorado Department of Transportation (CDOT) Realizes Benefits of Adopting a Digital Print System for Statewide Traffic Sign Production

CDOT first state agency in country to benefit from innovative solution

The Colorado Department of Transportation (CDOT) is no stranger to extreme road conditions, responsible for maintaining more than 184,000 miles of state and county roadways and ensuring the driving safety of its millions of residents and visitors. Part of that charge is the production of traffic signs, which must meet very strict requirements for reflectivity and durability in order to protect the public.

Traditional Screen Printing: Time to Move On

Like many DOTs around the country, CDOT for decades had utilized a traditional screen printing technique to turn out its signs. This process, a labor intensive one that requires a significant amount of time and resources to run successfully, was becoming a hindrance to the agency running at peak efficiency. Each screen requires a unique construction with careful maintenance, and the frequent possibility of damage that could result in the flawed print of a sign. Furthermore, the screens expose the shop staff to toxic chemicals that can only be disposed of by barrel storage and shipping to a specialized waste management facility. Because it is a facility that houses its entire sign manufacturing operation internally, the risk of CDOT employee strain by the chemical exposure was a real consideration. CDOT wanted to ensure excellent quality and the ability to immediately troubleshoot any hazardous environments. Without proper personal protective equipment, staff was at risk for developing headaches, skin allergies or asthma.



Colorado took note of the statistic by the Federal Highway Administration (FHWA) stating that states spend \$174 million annually on traffic sign replacement, and thought, “there has got to be a better way, for both our employees and the state’s taxpayers.”

The Digital Print Innovation

Because CDOT knew transforming its shop with a different printing method would require new equipment, it conducted a study comparing digital printing to traditional print methods of sign fabrication. The findings indicated that digitally-printed traffic signs using the right inks and protective overlays can be more durable and significantly easier to produce than those printed via traditional screen-printed methods. Additionally, due to the efficient nature of the process, using a digital print solution, Colorado could cut its print duration per sign, outputting in one hour what normally would have taken two days.

CDOT sign shop supervisor Bernard Cole said because of digital printing, “More dollars can be invested in maintaining roads, improving safety and reducing congestion. Digital printing techniques will also reduce the amount of hazardous waste produced in the process by using less ink and cleaning chemicals to produce the signs – protecting our employees.”

Enter Avery Dennison’s TrafficJet™ Print System. The digital solution is an integrated inkjet printing system that allows





“The digital printer has allowed us to go from ‘a few days’ to ‘instant’.”

—Bernard Cole, CDOT sign shop supervisor

CDOT to produce specification-compliant and durable traffic signs. It requires less space, equipment and inventory than traditional methods and is allowing CDOT to do more with less. The system can nest signs of various types, sizes and colors across the full sheeting width, which results in raw material cost reduction and streamlined operations.

Cole said of the print system, “The digital printer has allowed us to go from ‘a few days’ to ‘instant,’” and has increased CDOT’s capacity and capabilities.

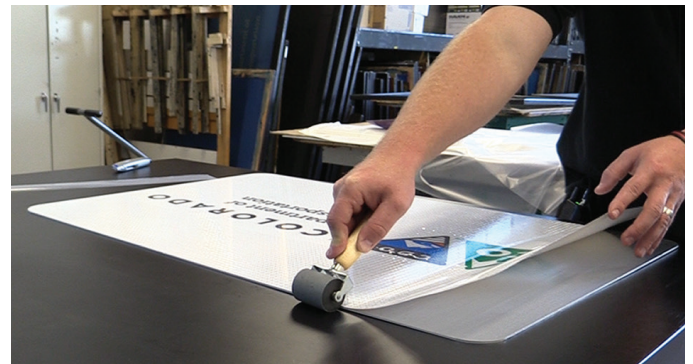
The digital system is allowing CDOT to get signs out the door faster than ever before and allows for more complex and colorful signs. Unlike the old screen-printing method where multiple colors took a long time to produce and dry

because of the layering technique, the print system is producing high-quality, multi-colored signs in one step.

Spreading the Word to Other State Agencies

CDOT, because of the success it’s having with the digital solution, is encouraging other city, county and state agencies to consider the innovation as well. “CDOT’s actually opening the door to new ideas and improvements for the safety of the traveling public,” said senior sign fabricator Damien Stelter.

“With this type of innovation we believe the ultimate winner will be the driving public, who will have a better functioning transportation system,” said Shailen Bhatt, executive director of CDOT. “Colorado is continually seeking to not just innovate on behalf of our employees, but also for a better return on the taxpayers’ investment.”



For more information on the innovation efforts from the Colorado DOT, please visit www.codot.gov. For more information on Avery Dennison’s TrafficJet print solution, please visit <http://reflectives.averydennison.com/en/home/about-us.html>



TrafficJet™ Print System

**The Revolutionary Printer
that will Simplify your World**



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April 27, 2015

Mr. Moe Madar
N.A. Regulatory Affairs Manager
Avery Dennison
7542 N. Natchez Ave.
Niles, IL 60714

Re: Avery Dennison TrafficJet Digital Printing System

Dear Moe Madar:

Avery Dennison's TrafficJet Digital Printing System has been evaluated and is approved for use to fabricate Construction Work Zone signs with Avery reflective sheeting listed on the Texas Department of Transportation's (TxDOT) Material Producer List (MPL) for Sign Face Materials. Construction Work Zone signs must be fabricated in accordance with the pertinent Work Zone (WZ) or Barricade and Construction (BC) standards.

Approval is also granted for the TrafficJet Digital Printing System as a substitute for permanent highway signs fabricated by a screen ink process. The signs must be fabricated only with Avery Dennison reflective sheeting listed on the Sign Face Materials MPL. Fabrication must be in accordance with the TxDOT's Typical Sign Requirements (TSR) Standards and Avery's sign fabrication recommendations. Per Avery Dennison's technical bulletin, fabrication of all permanent highway signs using the TrafficJet System requires the use of the OL-2000 overlay film. The TrafficJet System may only be used to fabricate signs where screen ink is permitted by the TSR Standards. All permanent highway signs fabricated using Avery Dennison's TrafficJet Digital Printing System must be warranted in accordance with the warranty provisions of TxDOT Material Specification DMS-8300, Sign Face Materials.

We appreciate your interest in doing business with the TxDOT. You may contact me concerning questions regarding this correspondence at 512/506-5889.

Sincerely,

Johnnie S. Miller, P.E.
Traffic Materials Branch Manager
Construction Division
Materials and Pavements Section

OUR GOALS

MAINTAIN A SAFE SYSTEM • ADDRESS CONGESTION • CONNECT TEXAS COMMUNITIES • BEST IN CLASS STATE AGENCY

An Equal Opportunity Employer



STANDARDS COMMITTEE REQUEST FORM

TRACKING# 16-0023
Coordinator assigns tracking # to request upon receiving.

DATE OF REQUEST: 8/5/2016

REQUESTOR'S ORGANIZATION: ADOT Construction & Materials Group

(If internal to ADOT, include District/Group Name)

REQUESTOR: Craig Wilson

PHONE: 602-712-7974

EMAIL: cwilson2@azdot.gov

PRIORITY LEVEL:

☐

High

☐

Medium

☒

Low

DESCRIPTION OF REQUEST:

Enter description of action being requested. Include type of action (new or revision) and provide document name, title, and section. If additional information is needed, please attach a separate document. Explain why request is a high, medium, or low priority.

We are requesting to revise Figure 2 of SERIES 1000 (CERTIFICATES) in the Materials Testing Manual. Figure 2 is the Materials Certificate Log (ADOT FORM 44-4409). The actual form was updated in 2015 and should be reflected in the example figure shown in Series 1000.

This is a low priority request because the updated form is already available to users, just not up to date in SERIES 1000.

REASON FOR REQUEST:

Enter a detailed description of why the action is being requested.

The Materials Certificate Log was updated in 2015 to include a column to remind inspectors to verify the "Buy America" statement on certificates for Steel and Iron.

LIST ALL SUPPORTING DOCUMENTATION THAT IS BEING SUBMITTED WITH THIS REQUEST:

Revised Form 44-4409

Submit completed form and all supporting documentation to Lisa Sinclair, ADOT Standards Committee Coordinator at lsinclair@azdot.gov.

ARIZONA DEPARTMENT OF TRANSPORTATION MATERIALS CERTIFICATE LOG

PROJECT NO. _____ CONTRACTOR _____ SHEET _____ OF _____

[illegible]

RESIDENT ENGINEER _____

DATE _____

(Signature)



STANDARDS COMMITTEE APPROVAL FORM

TRACKING NUMBER

16-0001

COMMITTEE USE ONLY

PART A:

TO BE USED TO APPROVE A REQUEST TO CREATE OR MODIFY A STANDARD

DATE COMMITTEE REVIEWED REQUEST:

6-16-16

REQUEST APPROVED AS SUBMITTED: X

REQUEST APPROVED WITH MODIFICATIONS:

REQUEST NOT APPROVED:


Standards Committee Chair

Modifications:

Reason Not Approved:

PRIORITY LEVEL:

 1

X 2

 3

Priority 1

Upon posting, the approved standard impacts all projects in construction, advertised, and in design at all stages. Change Orders or Addenda will be issued when necessary. If implementation will significantly impact the project then exceptions may be granted.

Priority 2

Upon posting, the approved standard impacts projects that have been advertised and projects in design at all stages. Addenda will be issued when necessary. If implementation will significantly affect the bidding of the project an exception may be granted.

Priority 3

Upon posting, the approved standard impacts all projects in design that have not reached stage IV (95%). If implementation on projects that have not reached stage IV is not practical then exceptions may be made.

SUBCOMMITTEE ASSIGNED:

Materials X

Traffic & Safety

Contract Administration

Bridges & Structures

Roadway

DATE SUBCOMMITTEE TO COMPLETE BY:

8-16-16

DOES REQUEST AFFECT THE DESIGN OR BIDDING:

YES

NO X

(IF NO THEN STANDARD CAN BE APPROVED BY THE
SUBCOMMITTEE GROUP MANAGER SPONSOR ACTING FOR THE COMMITTEE.)

(IF YES THEN STANDARD MUST BE APPROVED BY THE COMMITTEE)



STANDARDS COMMITTEE APPROVAL FORM

TRACKING NUMBER 16-001

PART B:

TO BE USED BY COMMITTEE CHAIR OR GROUP MANAGER SPONSOR TO APPROVE THE NEW OR REVISED STANDARD

REQUEST DOES NOT AFFECT DESIGN OR BIDDING

SUBCOMMITTEE GROUP MANAGER SPONSOR USE ONLY

COMMENTS:

APPROVED:

Julie E. Kleaver
GROUP MANAGER SPONSOR

DATE:

8/16/16

FHWA APPROVAL REQUIRED:

YES ☒

NO ☐

REQUEST AFFECTS DESIGN OR BIDDING

COMMITTEE CHAIR USE ONLY

COMMENTS:

APPROVED:

STANDARDS COMMITTEE CHAIR

DATE:

FHWA APPROVAL REQUIRED:

YES ☐

NO ☐

NOTE: Approved Standard Drawings must be signed by the technical group manager (Roadway, Bridge, Traffic, Etc.) who oversees the discipline the standard belongs to and the Chair of the Standards Committee to complete the approval process prior to posting.



STANDARDS COMMITTEE REQUEST FORM

TRACKING# 16-0001
Coordinator assigns tracking ID to request upon receiving.

DATE OF REQUEST: 5/16/16

REQUESTOR'S ORGANIZATION: ADOT Construction Materials Group

(If Internal to ADOT, include District/Group Name)

REQUESTOR: Jessica Banner

PHONE: 928-777-5899

EMAIL: jbanner@azdot.gov

PRIORITY LEVEL:

☐

High

☒

Medium

☐

Low

DESCRIPTION OF REQUEST:

Enter description of action being requested. Include type of action (new or revision) and provide document name, title, and section. If additional information is needed, please attach a separate document. Explain why request is a high, medium, or low priority.

416-7.03 Material Spread paragraph 3 and 417-7.03 Material Spread paragraph 3. I am requesting that paragraph 3 be revised.

REASON FOR REQUEST:

Enter a detailed description of why the action is being requested.

Paragraph 3 allows for the contractor to elect to use the production bulk density. It also states that changes to the bulk density will not be retroactive. I have seen two contractors request to use the average production bulk density. They get the average by taking the bulk density from the first 3 days of paving excluding the test lot. In order to get an average we have to wait until at least 3 lots of asphalt have been paved. The requests to use the average production bulk density are made prior to paving however we can not apply the average bulk density to lots 2, 3 or 4 because it would be considered retroactive.

LIST ALL SUPPORTING DOCUMENTATION THAT IS BEING SUBMITTED WITH THIS REQUEST:

I have attached a request to use the production bulk density.

Submit completed form and all supporting documentation to Lisa Sinclair, ADOT Standards Committee Coordinator at lsinclair@azdot.gov.

* USE STORED SPECIFICATION 109PAVSM WHEN AN *
 * INCENTIVE/DISINCENTIVE PAYMENT FOR ASPHALTIC CONCRETE *
 * PAVEMENT SMOOTHNESS IS SPECIFIED IN *
 * THE MATERIALS DESIGN REPORT *

* USE IN CONJUNCTION WITH THE FOLLOWING: *

* BID ITEM: 9240170 *

* STORED SPECIFICATIONS: 924CQC *

* 1001MATL *

* 1009ASRM *

* FILL IN THE FOLLOWING: *

* 415-3 UNIT WEIGHT (1 Place) *

* PERCENTAGE (1 Place) *

* 415-3.04 TYPE OF BITUMINOUS MATERIAL (1 Place) *

(415AREP, 01/26/16 XX/XX/16)

SECTION 415 ASPHALTIC CONCRETE (ASPHALT-RUBBER) – END PRODUCT:

415-1 Description: the first paragraph of the Standard Specifications to revised to read:

The work under this section shall consist of constructing Asphaltic Concrete (Asphalt-Rubber), hereinafter asphaltic concrete, by providing a mix design meeting the design criteria specified herein, furnishing all materials, mixing at a plant, hauling, and placing a mixture of aggregate materials, mineral admixture, and bituminous material (asphalt-rubber) to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of the specifications.

The contractor shall acquire and make all arrangements for a source or sources of material, furnish a mix design which will meet the design criteria specified hereinafter, and provide all the equipment, materials, and labor necessary to complete the work.

TABLE 415-1 ASPHALTIC CONCRETE MIX DESIGN CRITERIA: Item “1. Voids in Mineral Aggregate”, Item “2. Effective Voids”, and “Item 3. Absorbed Asphalt-Rubber” of the Standard Specifications are revised, and the Note is hereby deleted:

TABLE 415-1 ASPHALTIC CONCRETE MIX DESIGN CRITERIA		
Criteria	Requirements	Arizona Test Method
Voids in Mineral Aggregate, %, Minimum	19.0	832
Effective Voids, %, Range	5.0 ± 0.5	832
Absorbed Asphalt-Rubber, %, Range	0 – 1.0	832

415-3 Materials: of the Standard Specifications is modified to add:

For comparative purposes, quantities shown in the bidding schedule have been calculated based on the following data:

Unit Weight, lb./cu. ft.	<u>XXX</u>
Asphalt-Rubber, %	<u>X.X</u>
Mineral Admixture, %	1.0

415-3.01 Mineral Aggregate Source: the first paragraph of the Standard Specifications is revised to read:

The contractor shall provide a source in accordance with the requirements of Section 1001, except that sub-paragraph (3) under Subsection 1001-3.01(B) shall not apply.

415-3.02 Mineral Aggregate: "Carbonates" in TABLE 415-2 of the Standard Specifications is revised to read, and "Note 1" is added:

TABLE 415-2 MINERAL AGGREGATE CHARACTERISTICS		
Characteristics	Test Method	Requirement
Carbonates (1)	Arizona Test Method 238	Maximum 20%
Note: (1) Testing for carbonates only applies if either of the following conditions exist: (a) The asphaltic concrete is the designed final pavement surface normally used by traffic. (b) The asphaltic concrete, temporary or otherwise, will be subject to traffic for more than 60 days.		

415-3.03 Mineral Admixture: the last paragraph of the Standard Specifications is revised to read:

The certification and acceptance of Portland cement, blended hydraulic cement (Type IP), and hydrated lime shall be in accordance with ADOT Materials Policy and Procedure Directive No. 13, "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, Silica Fume, and Lime".

415-3.04 Bituminous Material: the first paragraph of the Standard Specifications is revised to read:

Bituminous material shall be asphalt-rubber conforming to the requirements of Section 1009 of the specifications. The asphalt-rubber shall be CRA Type XXXXX. The crumb rubber gradation shall be Type B conforming to the requirements of Section 1009.

415-4 Mix Design: the third through the sixth paragraphs of the Standard Specifications are revised to read:

The mix design shall be prepared by or under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. The mix design engineer shall meet the requirements given in ADOT Materials Policy and Procedure Directive No. 4, "Asphaltic Concrete Mix Design Proposals and Submittals". The mix design shall be provided in a format that clearly indicates all the mix design requirements and shall be sealed, signed, and dated by the mix design engineer.

The mix design shall be prepared by a mix design laboratory that has met the requirements of ADOT Materials Policy and Procedure Directive No. 19, "ADOT System for the Evaluation of Testing Laboratories".

The contractor may propose the use of a mix design that has been developed for a previous project. The proposed mix design shall meet the requirements of these specifications. The contractor shall provide evidence that the type and source of bituminous material, the type of mineral admixture, and the source and methods of producing mineral aggregate, have not changed since the formulation of the previous mix design. The contractor shall also provide current test results for all specified characteristics of the mineral aggregate proposed for use. The Engineer will determine if the previously used mix design is suitable for the intended use and if the previous use of the mix design was satisfactory to the Department. The Engineer will either approve or disapprove the proposed mix design. Should the Engineer disapprove the use of the previously used mix design, the contractor shall prepare and submit a new mix design proposal in accordance with the requirements of these specifications.

A previously used mix design older than two years from the date it was formulated, sealed, signed, and dated shall not be allowed for use. Once approved for use on a project, a mix design may be used for the duration of that project.

415-4 Mix Design: the eleventh paragraph of the Standard Specifications is revised to read:

A copy of the mix design and representative samples of the materials used in the mix design shall be submitted to the Engineer for calibration of the ignition furnace, and for the determination of sand equivalent, fractured coarse aggregate particles, and uncompacted void content. Approximately 300 pounds of mineral aggregate (proportional to the mix design gradation), three gallons of asphalt-rubber, and one gallon of mineral admixture shall be submitted. The Engineer shall witness the sampling of the mineral aggregate. The mix

design and samples shall be submitted to the Engineer at least five working days prior to the start of asphaltic concrete production.

415-4 Mix Design: the fifteenth, sixteenth, and seventeenth paragraphs of the Standard Specifications are revised to read:

If the contractor elects to change its source(s) of mineral aggregate, or adds or deletes the use of a stockpile(s) regardless of source, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

If changes are made in the source or type of bituminous material, or the type of mineral admixture, the contractor shall provide verification testing results. Verification testing shall be performed at the original mix design asphalt content using the original mineral aggregate, the proposed bituminous material, and/or the proposed mineral admixture. Three specimens shall be fabricated and tested for bulk density, maximum theoretical density, and effective voids. The percent effective voids must be within ± 0.2 of the percent effective voids in the original design and also be within the current effective voids mix design specification limits. Verification testing results shall not replace target values shown in the original mix design. All target values from the original design shall be used in future production with the exception of any self-directed target value changes that are requested. The verification process does not ensure that the contractor can meet the target values during production.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing and acknowledged by the Engineer prior to start of production for a lot. Self-directed target changes shall meet contract requirements for mix design criteria and grading limits.

MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (sieve size): 3/8 inch No. 4 No. 8 No. 200	$\pm 4\%$ from mix design target value $\pm 4\%$ from mix design target value $\pm 4\%$ from mix design target value $\pm 0.5\%$ from mix design target value
Asphalt-Rubber Content	$\pm 0.2\%$ from mix design target value
Effective Voids	None

The contractor may propose target changes to the approved mix design for the Engineer's approval. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and grading limits. For acceptance purposes, target changes will not be retroactive.

In no case shall the approval of mix design changes relieve the contractor of the responsibility for the results obtained by the use of such approved changes.

- 415-5 Contractor Quality Control:** the header and “Voids” in the table of the Standard Specifications are revised to read:

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	TEST METHOD	SAMPLING POINT	MINIMUM TESTING FREQUENCY
Mineral Aggregate for Asphaltic Concrete			
Voids	ARIZ 410, 415, 417, 424	Roadway or Plant	1 per 1000 Tons each day. Maximum of 4 per day.

- 415-6 Construction Requirements:** the fifth paragraph of the Standard Specifications is revised to read:

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

Self-propelled paving machines shall spread the mixture within the specified tolerances, without segregation or tearing, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which shall distribute the mixture uniformly in front of adjustable screeds.

- 415-6 Construction Requirements:** the twelfth paragraph of the Standard Specifications is revised to read:

All wheels and tires of compactors and other equipment surfaces shall be treated when necessary with a release agent approved by the Engineer in order to prevent the sticking of asphaltic concrete. Release agents which degrade, dissolve, or in any way damage the bituminous material shall not be used. Diesel fuel shall not be used as a release agent.

- 415-6 Construction Requirements:** the last four paragraphs of the Standard Specifications are revised to read:

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked in accordance with the requirements of Section 404. The cleaning of the surface, the tacking of the surface, and the type of bituminous material used shall be acceptable to the Engineer. The amount of bituminous material used shall be as directed by and acceptable to the Engineer.

A light coat of bituminous material shall be applied to edges or vertical surfaces against which asphaltic concrete is to be placed.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement

of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

Asphaltic concrete delivered to the screed unit shall be a free flowing, homogeneous mass in which there is no segregation, crusts, lumps, or migration of the asphalt-rubber. Should any one or more of such conditions be evident in the material delivered to the screed unit, the Engineer will order the work to be stopped until conditions are conducive to the delivery of the material in the condition as hereinbefore required.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent. The moisture content will be determined in accordance with Arizona Test Method 406.

415-7.02 Sand Equivalent, Fractured Coarse Aggregate Particles, and Uncompacted Void Content of Mineral Aggregate: the second paragraph of the Standard Specifications is revised to read:

Mineral aggregate will be acceptable for sand equivalent if it meets the minimum requirements specified in Subsection 415-3.02.

415-7.03 Material Spread: the last three paragraphs of the Standard Specifications are revised to read:

The Engineer will calculate the quantity required in each spread lot using the mix design bulk density unless a request is made by the contractor to use a production bulk density. If a request is made to use production bulk density, the first three non-rejected lots following the test lot will be used to determine the average production bulk density. All lots placed prior to establishing the average production bulk density shall be calculated using the mix design bulk density. For each new mix design used on the project, a new production bulk density may be requested by the contractor. In addition, if conditions warrant during asphalt production, the contractor may request establishment of a new average production bulk density. A request All requests to use a production bulk density shall be made in writing and approved by the Engineer prior to use. The same procedure will be used for determining average production bulk density in all cases. Changes to the bulk density for calculating spread quantities will ~~shall~~ not be retroactive.

The calculated quantity required in each spread lot will be compared to the actual quantity placed. A lot will be considered to be acceptable, with a zero pay factor, if the actual quantity placed varies by no more than -2.0 to +5.0 percent from the required quantity.

If the quantity in a lot is found to vary from the required quantity by -2.1 to -12.0 percent, the appropriate pay factor will be determined in accordance with Table 415-4. This pay factor will be utilized in determining the pay adjustment as outlined in Subsection 415-9.

415-7.04 Gradation, Asphalt Cement Content, and Effective Voids: of the Standard Specifications is revised to read:

A mixture properties lot shall be considered to be one shift's production. In the event a shift's production is less than 1200 tons, multiple shifts may be combined to form a lot. When a lot consists of production from more than one shift, the following conditions apply: at least one sample shall be taken each shift, at least one sample shall be taken every 500 tons, and no mix design or target value changes shall be made within the lot. If changes are made in the mix design or target values, new lots will be established.

Four samples of the asphaltic concrete shall be taken for each lot by the contractor, under the observation of the Engineer, at random locations designated by the Engineer. Samples will be taken in accordance with the requirements of Section 2 or 3 of Arizona Test Method 104. The samples shall be delivered to the Engineer immediately after being taken. The minimum weight of the sample shall be 75 pounds. The Engineer will split the sample and save one-half for 15 days after written notification to the contractor of test results for that lot has been made. The material will be tested by the Engineer for the following properties:

Test Property	Test Method
Asphalt-Rubber Content	Arizona Test Method 427 (See Notes 1 and 2 below)
Gradation	
Marshall Density	Arizona Test Method 410
Maximum Theoretical Density	Arizona Test Method 417
Effective Voids	Arizona Test Method 424
Notes: (1) A new calibration of the ignition furnace shall be performed for each mix design, and at any other time the Engineer directs. (2) Ignition furnace results for asphalt-rubber content will be corrected in accordance with the paragraph below as required.	

For plants providing asphaltic concrete exclusively for the project, the difference between the asphalt-rubber content as measured by ignition furnace testing and the actual asphalt-rubber content shall be determined by the Engineer for each of the first five lots of asphaltic concrete produced for each mix design. If there are less than five lots for the mix design, the total number of available lots shall be used. If approved by the Engineer, a plant may be considered exclusive to the project if an asphalt-rubber tank is dedicated for the shift of asphaltic concrete production. The determination of the actual asphalt-rubber content may include invoice quantities, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted materials. If a computerized mass-flow meter is used, documentation of its calibration shall be submitted to the Engineer prior to asphaltic concrete production. At any time during asphaltic concrete production, the Engineer may require that a new calibration of the mass-flow meter be performed. If the average difference exceeds ± 0.10 percent asphalt-rubber content between the asphalt-rubber content measured by ignition furnace testing and the actual asphalt-rubber content, the contractor may request that a correction to the asphalt-rubber content by ignition furnace testing be made. The contractor must make such a request in writing within two working

days after receiving the test results for the fifth lot of asphaltic concrete production. If referee testing is performed on a lot of asphaltic concrete for which a correction, based on the actual asphalt-rubber content, was made to the asphalt-rubber content by ignition furnace testing, referee testing shall not apply to the determination of asphalt-rubber content. The correction, once documented and approved by the Engineer, shall be applied to test results from the beginning of asphaltic concrete production through the remainder of asphaltic concrete production using that mix design; however, a new correction may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances. If the contractor submits a new mix design, a new correction must be established and applied as specified above. For other plants, no correction will be made to asphalt-rubber content values measured by ignition furnace testing.

Acceptance testing results will be furnished to the contractor within four working days of receipt of samples by the Engineer.

The target values for gradation, asphalt-rubber content, and effective voids are given in the contractor's mix design. The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each of the measured characteristics are as follows:

Measured Characteristics	LL	UL
Gradation (sieve size):		
3/8-inch	TV – 6.0	TV + 6.0
No. 4	TV – 6.0	TV + 6.0
No. 8	TV – 6.0	TV + 6.0
No. 200	TV – 2.0	TV + 2.0
Asphalt-Rubber Content	TV – 0.60	TV + 0.60
Effective Voids	TV – 2.0	TV + 2.0
Note: The limits are used in the statistical calculations for Quality Index. Acceptance is controlled by the variability of the produced material and every effort should be made to strive for the applicable target value (TV).		

The Engineer will determine the PT for each measured characteristic in accordance with Subsection 415-9(I), and utilizing Table 415-4 will determine the pay factor for each measured characteristic.

In the event the contractor elects to question the mixture property test results, the contractor may request referee testing in accordance with Subsection 415-9(J).

415-7.05 Compaction: the third through the eighth paragraphs of the Standard Specifications are revised to read:

All edges shall be rolled by methods approved by the Engineer, while the mixture is still hot.

A compaction lot shall be identical to the mixtures properties lot described in Subsection 415-7.04. Lots encompassing more than one project shall be separated in accordance with Subsection 415-9(D). Each lot shall be tested for acceptance.

Twenty cores shall be taken for each lot by the contractor, under the observation of the Engineer. Cores shall be taken using wet coring with soapy water to aid in the release of the core from the coring equipment. The Engineer will designate ten random locations within the lot and the contractor shall take two cores at each location; however, if more than one shift constitutes a lot, two cores shall be taken from a minimum of two random locations each shift, or as directed by the Engineer. The Engineer will save one core from each location for 15 days after written notification to the contractor of test results for that lot has been made. Randomly selected locations will be determined to the nearest one-half foot in the transverse direction and to the nearest one foot in the longitudinal direction of the pavement course; however, the outside one foot of the unconfined pavement course will be excluded from testing as shown in ADOT Materials Policy and Procedure Directive (P.P.D.) No. 18, "Determining Sample Times and Locations for End Product Asphaltic Concrete". P.P.D. No. 18 also addresses areas to be excluded relative to longitudinal joints. Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104. Cores shall be a minimum of four inches in diameter and shall be taken not later than two working days after placement of the asphaltic concrete. The cores shall be delivered to the Engineer immediately upon being taken. The bulk density of each core will be determined by the Engineer in accordance with the requirements of Arizona Test Method 415. The test results will be furnished to the contractor within four working days of receipt of cores by the Engineer.

The target value for compaction shall be 7.0 percent in-place air voids. In-place air voids shall be determined in accordance with Arizona Test Method 424. The maximum theoretical density used in the determination of air voids will be the average of the four maximum theoretical densities determined for the lot in Subsection 415-7.04.

The Upper Limit (UL) is 9.0 percent in-place air voids and the Lower Limit (LL) is 3.5 percent in-place air voids. The Engineer will determine the PT for compaction in accordance with Subsection 415-9(I), and utilizing Table 415-4 will determine the compaction pay factor.

In the event the contractor elects to question the core test results, the contractor may request referee testing in accordance with Subsection 415-9(J).

415-8 Method of Measurement: the second paragraph of the Standard Specifications is revised to read:

Asphalt-rubber will be measured by the ton on the basis of the asphalt-rubber content determined in accordance with Subsection 415-7.04 for each lot of asphaltic concrete accepted. The average asphalt-rubber content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt-rubber. If the contractor has requested referee testing, the average asphalt-rubber content will come from the independent testing laboratory results, unless a correction, based on the actual asphalt-rubber content, was made to the ignition furnace test value as allowed in Subsection 415-7.04. If a correction, based on the actual asphalt-rubber content, was made to the ignition furnace test value, the average asphalt-rubber content determined from the Department's acceptance testing will be used. At the discretion of the Engineer,

asphalt-rubber may be measured by invoice quantities, adjusted as necessary for waste. Waste generated from startup of the asphalt plant will be considered to have a binder content of 3.0 percent. In no case shall the measured amount of asphalt-rubber for payment be greater than the total of the invoice quantities, adjusted for waste.

415-8 Method of Measurement: the third paragraph of the Standard Specifications is revised to read:

Mineral admixture will be measured by the ton for the mineral admixture actually used in accordance with Subsection 403-2.

415-9 Basis of Payment: the first, second, and third paragraphs of the Standard Specifications are revised to read:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price adjusted by the appropriate pay factors as hereinafter provided.

For the purpose of determining acceptability and appropriate pay factors, each unit of asphaltic concrete will be included in three separate lots: a "spread lot," a "mixture-properties lot," and a "compaction lot." The total unit price for any unit of accepted asphaltic concrete will be the contract unit price, adjusted by the applicable spread lot pay factor, mixture-properties lot pay factor, and compaction lot pay factor.

The contractor may request to place the first lot of each mix type as a test strip. Requests to place a test strip shall be made in writing and acknowledged by the Engineer prior to start of production. A test strip shall be limited to 1,000 tons and may only be placed on shoulders, ramps, cross roads, or other areas approved by the Engineer. A test strip shall be excluded from the mixture properties lot pay factor and the compaction lot pay factor; however, all other provisions of Subsection 415-9 shall still apply to such areas.

The Engineer may exclude asphaltic concrete from the spread lot and from the spread lot pay factor calculations if the Engineer determines that the proposed use of the material or the existing surface conditions are not conducive to the use of spread lots.

The Engineer may exclude certain locations from the mixture properties lot and/or the compaction lot and from the random sampling used in determining the mixture properties lot pay factor and/or the compaction lot pay factor should the Engineer determine that the location of the work precludes normal construction operations.

415-9(A) Spread Lot Pay Factor: of the Standard Specifications is revised to read:

The spread lot pay factor will be determined in accordance with Subsection 415-7.03. If the quantity in a spread lot is found to vary by more than + 5.0 percent from the required quantity, no payment will be made for the material which exceeds + 5.0 percent, including asphalt cement and mineral admixture. If the quantity is found to vary by more than - 12.0 percent from the required quantity, the spread lot will be rejected.

415-9(C) Compaction Lot Pay Factor: of the Standard Specifications is revised to read:

The compaction lot pay factor shall be determined as set forth in Subsection 415-7.05.

415-9(E) Acceptability: the second, third, and fourth paragraphs of the Standard Specifications are revised to read:

Within 15 days after receiving notice that a spread lot, mixture properties lot, or compaction lot of asphaltic concrete has been rejected by the Engineer, the contractor may submit a written proposal to accept the material in place at the applicable maximum negative pay factor(s). Maximum negative pay factors are defined as a minus \$1.00 per ton for spread lots, minus \$5.00 per ton for compaction lots, minus \$3.00 per ton for mixture properties lots in reject for gradation only, minus \$5.00 per ton for mixture properties lots in reject for asphalt-rubber content and/or effective voids only, and minus \$5.00 per ton for mixture properties lots in reject for asphalt-rubber content and/or effective voids and also gradation. Positive mixture properties lot pay factors become zero when the compaction lot is in reject and the material is allowed to be left in place. In addition, for any mixture properties lot that is in reject due to asphalt-rubber content but allowed to remain in place, payment shall not be made for asphalt-rubber quantities in excess of the upper limit (UL) as determined in Subsection 415-7.04(A).

The proposal shall contain an engineering analysis of the anticipated performance of the asphaltic concrete if left in place. The engineering analysis shall also detail any proposed corrective action, and the anticipated effect of such corrective action on the performance. The engineering analysis shall be performed by an independent professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected mixture properties lot or a rejected compaction lot is submitted for referee testing by the contractor, the 15 days allowed to prepare an engineering analysis will begin upon notification of referee test results.

Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is not accepted, the asphaltic concrete shall be removed at no additional cost to the Department and replaced with asphaltic concrete meeting the requirements of these specifications. If the proposal is accepted, the asphaltic concrete shall remain in place at the applicable maximum negative pay factor(s), and any necessary corrective action shall be performed at no additional cost to the Department.

TABLE 415-4 PAY FACTORS: the pay factors for both "Effective Voids" and "Compaction" with a PT of 100, and the pay factor for "Compaction" with a PT of 65-69, of the Standard Specifications are revised to read:

TABLE 415-4 PAY FACTORS					
Material Spread		Mixture Properties and Compaction			
Negative Variance	Pay Factor	PT	Pay Factors(Dollars per Ton)		
			Gradation	Effective	Compaction

%	(Dollars per Ton)		and Asphalt-Rubber Content	Voids	
2.1 - 3.0	- 0.10	100	0.00	+ 2.00	+ 2.00
9.1 - 10.0	- 0.80	65 - 69	- 1.00	- 1.25	- 1.25

415-9(J) Referee Testing: is hereby added to the Standard Specifications:

(1) Referee Testing Performed for Mixture Properties Only:

Within 15 days after written notification to the contractor of test results for a particular mixture properties lot, the contractor may make a written request for referee testing. The referee testing shall be performed by an independent approved laboratory designated by the Department. The testing of the samples will be performed by the independent testing laboratory without knowledge of the specific project conditions such as the identity of the contractor or mix design laboratory, the test results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for the following properties:

Test Property	Test Method
Asphalt-Rubber Content (See Note 1 below)	Arizona Test Method 427
Gradation	
Marshall Density	Arizona Test Method 410
Maximum Theoretical Density	Arizona Test Method 417
Effective Voids	Arizona Test Method 424
<p>Note:</p> <p>(1) If a correction to the asphalt-rubber content by ignition furnace testing is made in accordance with Subsection 415-7.04, the asphalt-rubber content shall not be subject to referee testing.</p>	

The results of the referee testing will be binding on both the contractor and the Department.

Using the referee testing results, the Engineer will determine new PT's for all characteristics, with the exception of asphalt-rubber content if a correction to the ignition furnace value was made as specified in Subsection 415-7.04.

When referee testing is performed on a mixture properties lot, the referee test result for the average maximum theoretical density will be used to determine a new PT for compaction.

The Department will pay for the referee testing; however, if the combined pay factor of the lot (Mixture Properties plus Compaction) does not improve or is reduced, or if either the mixture properties lot or compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties of that particular lot.

(2) Referee Testing Performed for Compaction Only:

Within 15 days after written notification to the contractor of test results for a particular compaction lot, the contractor may make a written request for referee testing. The bulk density of each of the cores previously saved will be determined in accordance with the requirements of Arizona Test Method 415 by an independent testing laboratory designated by the Department. The testing of the cores will be performed by the independent testing laboratory without knowledge of the specific project conditions, such as the identity of the contractor or mix design laboratory, or the test results by the Department. The percent air voids will be determined in accordance with Arizona Test Method 424. The maximum theoretical density used in the determination of air voids will be the average of the four maximum theoretical densities determined for the lot in Subsection 415-7.04.

The results of the referee testing will be binding on both the contractor and the Department.

When referee testing is performed on the compaction lot, the Engineer will determine a new PT for compaction using the referee testing results.

The Department will pay for the referee testing; however, if the pay factor of the compaction lot does not improve or is reduced, or the compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete will be reduced by the amount of the cost of referee testing for the compaction of that particular lot.

(3) Referee Testing Performed for Both Mixture Properties and Compaction:

When referee testing is performed, as described above, for both the mixture properties lot and the compaction lot, the Engineer will use the referee test results to determine new PT's as specified in Subsections 415-9(J)(1) and 415-9(J)(2).

The Department will pay for the referee testing; however, if the combined pay factor of the lot (Mixture Properties plus Compaction) does not improve or is reduced, or if either the mixture properties lot or compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties and compaction of that particular lot.

* USE STORED SPECIFICATION 109PAVSM WHEN AN *
 * INCENTIVE/DISINCENTIVE PAYMENT FOR ASPHALTIC CONCRETE *
 * PAVEMENT SMOOTHNESS IS SPECIFIED IN *
 * THE MATERIALS DESIGN REPORT *

* USE IN CONJUNCTION WITH THE FOLLOWING: *

* BID ITEM: 9240170 *
 * STORED SPECIFICATIONS: 924CQC *
 * 1001MATL *

* FILL IN THE FOLLOWING: *

* 416-2 EFFECTIVE VOIDS (As Needed) *
 * RATIO MINIMUM VALUE (1 place) *
 * 416-3 UNIT WEIGHTS (As Needed) *
 * PERCENTAGES (As Needed) *
 * 416-3.03(B) TYPE OF ASPHALT BINDER (1 place) *

(416ACES, 01/26/16 XX/XX/16)

SECTION 416 ASPHALTIC CONCRETE – END PRODUCT: of the Standard
 Specifications is revised to read:

416-1 Description:

The work under this section shall consist of constructing Asphaltic Concrete-End Product, hereinafter asphaltic concrete, by furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture, and bituminous material (asphalt cement) to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of the specifications.

Reclaimed asphalt pavement (RAP), as defined in Subsection 416-3.04, may be used in the mixture provided all requirements of the specifications are met; however, RAP will not be allowed in the mixture when asphalt cement type PG 76-22 TR+ or PG 70-22 TR+ is specified in Subsection 416-3.03 (B). References to the use of RAP in this section apply only if RAP is utilized as part of the mixture. ADOT Materials Policy and Procedure Directive No. 20, "Guidance on the Use of Reclaimed Asphalt Pavement (RAP) in Asphaltic Concrete", shall be used in conjunction with the requirements of the specifications.

Warm Mix Asphalt (WMA) technologies may be used in the mixture at the option of the contractor provided all requirements of the specifications are met. WMA is defined as asphaltic concrete that is produced within the temperature range of 215 to 275 °F. WMA can be produced by one or a combination of several WMA technologies including plant water foaming processes, mineral additives, and chemical additives. The requirements for incorporating WMA technologies in the mixture are given in these specifications and in Materials Policy and Procedure Directive No. 23, "Requirements for the Use of Warm Mix Asphalt (WMA) Technologies in Asphaltic Concrete".

The contractor shall acquire and make all arrangements for a source or sources of material, furnish a mix design which will meet the design criteria specified hereinafter, and provide all the equipment, materials, and labor necessary to complete the work.

416-2 Asphaltic Concrete Mix Design Criteria:

Mix designs shall be developed by the contractor on the basis of the following criteria and tested in accordance with the requirements of the following test methods:

Criteria	Requirements			Arizona Test Method
	1/2" Mix	3/4" Mix	Base Mix	
1. Voids in Mineral Aggregate: %, Range	15.5 - 18.5	15.0 - 18.0	14.5 - 17.0	Note (1)
2. Effective Voids: %, Range	<u>X.X</u> ± 0.2	<u>X.X</u> ± 0.2	<u>X.X</u> ± 0.2	Note (1)
3. Absorbed Asphalt: %, Range	0 - 1.0	0 - 1.0	0 - 1.0	Note (1)
4. Index of Retained Strength: %, Minimum	60 Note (2)	60 Note (2)	60 Note (2)	Note (3)
5. Wet Strength: psi, Minimum	150	150	150	Note (3)

6. Stability: pounds, Minimum	2,000		2,000		3,000		Note (1)
7. Flow: 0.01-inch, Range	8 - 16		8 – 16		8 - 16		Note (1)
8. Mix Design Grading Limits:							201
Sieve Size	Percent Passing						
	1/2 inch Mix		3/4 inch Mix		Base Mix		
	Without Admix.	With Admix.	Without Admix.	With Admix.	Without Admix.	With Admix.	
1-1/4 in.					100	100	
1 inch			100	100	90 -100	90 – 100	
3/4 inch	100	100	90 – 100	90 – 100	85 – 95	85 – 95	
1/2 inch	90 – 100	90 – 100	---	---	---	---	
3/8 inch	67 – 82	67 – 82	62 – 77	62 – 77	57 – 72	57 – 72	
No. 8	40 – 48	41 – 49	37 – 46	38 – 47	32 – 42	33 – 43	
No. 40	10 – 18	11 – 19	10 – 18	11 – 19	8 – 16	9 – 17	
No. 200	1.5 – 4.5	2.5 – 6.0	1.5 – 4.5	2.5 – 6.0	1.5 – 3.5	2.5 – 5.0	
<p>(1) For mixes without RAP, Arizona Test Method 815. For mixes with RAP, Arizona Test Method 833.</p> <p>(2) If the average elevation of the project is above 3500 feet, the index of retained strength shall be a minimum of 70 percent.</p> <p>(3) For mixes without RAP, Arizona Test Method 802 (as modified by Arizona Test Method 815). For mixes with RAP, Arizona Test Method 802 (as modified by Arizona Test Method 833).</p> <p>(4) The ratio of the mix design composite gradation target for the No. 200 sieve, including mineral admixture, to the effective asphalt content shall be within the range specified below:</p> $\frac{\text{Mix Design Composite Gradation Target}}{\text{Effective Asphalt Content}} = \underline{\text{X.X}} \text{ to } 1.2$							

416-3 Materials:

For comparative purposes, quantities shown in the bidding schedule have been calculated based on the following data:

(In the following two tables, use only the columns called for in the Materials Design Report; exclude all of either table if no column is called for in the Materials Design Report.)

Standard Mixes	1/2" Mix	3/4" Mix	Base Mix
Unit Weight, (lb./cu. ft.)	<u>XXX</u>	<u>XXX</u>	<u>XXX</u>
Asphalt Cement, %	<u>X.X</u>	<u>X.X</u>	<u>X.X</u>
Mineral Admixture, %	1.0	1.0	1.0

Special Mixes	1/2" Mix	3/4" Mix	Base Mix
Unit Weight, (lb./cu. ft.)	<u>XXX</u>	<u>XXX</u>	<u>XXX</u>
Asphalt Cement, %	<u>X.X</u>	<u>X.X</u>	<u>X.X</u>
Mineral Admixture, %	1.0	1.0	1.0

416-3.01 Mineral Aggregate:**(A) General:**

Mineral aggregate shall consist of virgin aggregate, or a combination of virgin aggregate and aggregate from RAP (RAP aggregate). When the terms "mineral aggregate" or "aggregate" are used without being further described as "virgin" or "RAP", the intended meaning is the total aggregate material used in the mixture.

No individual stockpile or hot bin usage of either virgin aggregate or RAP aggregate shall be less than three percent of the total mineral aggregate.

(B) Virgin Mineral Aggregate:

The contractor shall provide a source in accordance with the requirements of Section 1001, except that sub-paragraph (3) under Subsection 1001-3.01(B) shall not apply.

Coarse virgin mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

For areas or applications where Special Mix is not called for on the plans, fine virgin mineral aggregate shall consist of natural sand or of sand prepared from rock, or other approved inert materials, or a combination thereof, conforming to the requirements of these specifications.

For areas or applications where Special Mix is called for on the project plans, the following shall apply:

Fine virgin mineral aggregate shall be obtained from crushed gravel or crushed rock. All uncrushed material passing the No. 4 sieve shall be removed prior to the crushing, screening, and washing operations necessary to produce the specified gradation. The contractor shall notify the Engineer a minimum of 48 hours in advance of crushing the material to be used as virgin mineral aggregate, so all crushing operations can be inspected. Existing stockpile material which has not been inspected during crushing will not be permitted for use unless the contractor is able to document to the Engineer's satisfaction that the virgin mineral aggregate has been crushed. Any material inspected by the Department as crushed material for the project shall be separated from the contractor's other stockpiles and reserved for use throughout the project duration.

The contractor may blend uncrushed fine virgin aggregate up to a maximum of 15 percent of the total aggregate for mixes not containing RAP, or up to a maximum

of 10 percent of the total aggregate for mixes containing RAP. The total composite of virgin fine aggregate shall meet the requirement for uncompacted void content. The uncrushed fine virgin aggregate shall be 100 percent passing the 1/4 inch sieve and contain not more than 4.0 percent passing the No. 200 sieve. Should the contractor modify the method of producing either the uncrushed or crushed fine aggregate, the Engineer shall be immediately notified and the materials sampled and tested for determination of uncompacted void content.

(C) RAP Mineral Aggregate:

RAP aggregate shall consist of the aggregate portion of the reclaimed asphalt pavement. A maximum of 25 percent RAP aggregate, by weight of total aggregate in the mix, may be used in mixes placed in a lower lift (minimum 2" below finished surface). A maximum of 20 percent RAP aggregate, by weight of total aggregate in the mix, may be used at all other locations.

(D) Mineral Aggregate Characteristics:

Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent the thorough coating with the asphalt cement.

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Oven Dry Specific Gravity (1)	Arizona Test Method 251	2.350 - 2.850
Combined Water Absorption (1)	Arizona Test Method 251	0 - 2.5%
Sand Equivalent (1)	AASHTO T 176 (After thoroughly sieving the sample, no additional cleaning of the fines from the plus No. 4 material is required.)	Minimum 55
Abrasion (2)	AASHTO T 96	100 Rev., Max. 9% 500 Rev., Max. 40%
Fractured Coarse Aggregate Particles (3)	Arizona Test Method 212	Minimum 70% (4) (at least one fractured face, determined on plus No. 4 material)
Uncompacted Void Content (1) (Special Mix Only)	Arizona Test Method 247	Minimum 45.0%
Carbonates (3) and (5)	Arizona Test Method 238	Maximum 20%

Notes:

- (1) When the mix design contains RAP, the requirements shall be for the virgin aggregate portion only.
- (2) Abrasion shall be performed separately on materials from each source of mineral aggregate, including RAP aggregate. All sources shall meet the requirements for abrasion.
- (3) When the mix design contains RAP, the requirements shall be for the composite of virgin and RAP aggregate.
- (4) When Special Mix is called for on the project plans, this value shall be minimum 85% with at least two fractured faces and minimum 92% with at least one fractured face, determined on plus No. 4 material.
- (5) Testing for carbonates only applies if either of the following conditions exist:
 - (a) The asphaltic concrete is the designed final pavement surface normally used by traffic.
 - (b) The asphaltic concrete, temporary or otherwise, will be subject to traffic for more than 60 days.

Tests on aggregates outlined above, except for abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. When RAP is used in the mixture, RAP aggregates for testing shall be obtained from the RAP material using Method A of AASHTO T 164, prior to combining with the virgin aggregate.

Virgin mineral aggregate from a source or combination of sources which does not meet the requirements given in the table above for combined bulk oven dry specific gravity, and/or combined water absorption (up to a maximum of 3.0 percent), but meets the other specified requirements, will be considered for acceptance by the Engineer if: a) the total estimated cost of all asphaltic concrete components, using the mix design unit weight, asphalt cement content, and mineral admixture percentage, does not exceed the total amount bid for these items by more than 5.0 percent; or b) a supplemental agreement is executed adjusting the unit prices of asphaltic concrete components such that the total estimated cost does not exceed the total amount bid by more than 5.0 percent.

416-3.02 Mineral Admixture:

Mineral admixture will be required. The amount used shall be 1.0 percent, by weight of the mineral aggregate, unless testing demonstrates that additional admixture is required in order to meet the mix design criteria for Wet Strength and Index of Retained Strength. A maximum of 2.0 percent admixture will be permitted. The exact amount of admixture required shall be specified in the mix design. Mineral admixture shall be either Portland cement, blended hydraulic cement or hydrated lime conforming to the following requirements.

Material	Requirement
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

The certification and acceptance of Portland cement, blended hydraulic cement (Type IP), and hydrated lime shall be in accordance with ADOT Materials Policy and Procedure Directive No. 13, "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, Silica Fume, and Lime".

416-3.03 Bituminous Material:

(A) General:

Bituminous material shall consist of performance grade (PG) asphalt binder (virgin binder), or a combination of virgin binder and binder from RAP (RAP binder). When the terms "bituminous material", "asphalt cement", "asphalt binder" or "binder" are used without being further described as "virgin" or "RAP", the intended meaning is the total bituminous material used in the mixture.

The percent of asphalt cement used shall be based on the weight of total mix (asphalt cement, mineral aggregate, and mineral admixture).

(B) Virgin Bituminous Material:

Virgin asphalt cement shall be a performance grade (PG) asphalt binder, conforming to the requirements of Section 1005. The type of virgin asphalt binder shall be PG **XXXXX** or, if RAP is used in the mixture, the virgin asphalt binder shall be as required to meet the blending requirements in Subsection 416-3.03(C) and Arizona Test Method 833.

The contractor shall provide the laboratory mixing and compaction temperature ranges to the mix design laboratory for each PG asphalt binder used for mix design purposes. The laboratory mixing temperature range is defined as the range of temperatures where the un-aged virgin asphalt binder has a rotational viscosity of 0.17 ± 0.02 Pascal-seconds, measured in accordance with AASHTO T 316. The laboratory compaction temperature range is defined as the range of temperatures where the un-aged virgin asphalt binder has a rotational viscosity of 0.28 ± 0.03 Pascal-seconds, measured in accordance with AASHTO T 316. The testing required in AASHTO T 316 shall be performed at 275 °F and 350 °F, and a viscosity-temperature curve developed in accordance with ASTM D 2493. The viscosity-temperature curve shall be included in the mix design report. For PG asphalt binders that have a maximum laboratory mixing temperature exceeding 325 °F or a maximum laboratory compaction temperature exceeding 300 °F, the laboratory mixing and compaction temperature ranges shall be specified in writing by the virgin asphalt binder supplier. A viscosity-temperature curve will meet this requirement for written documentation if the viscosity-temperature curve is developed and submitted by the binder supplier and includes language that the recommended laboratory mixing and compaction temperatures are within acceptable ranges, and the submittal includes a statement indicating the

maximum laboratory mixing temperature to which the binder can be heated without damage. The laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used, shall be reported on the mix design. The contractor shall ensure that the asphalt binder supplier information required in this paragraph is provided to all appropriate parties in a timely manner, and that copies are included in the mix design report. The laboratory mixing and compaction temperatures are for mix design purposes only. Field mixing and compaction temperatures are specified in Subsections 416-6 and 416-7.

(C) RAP Bituminous Material:

RAP binder shall consist of the asphalt binder portion of the reclaimed asphaltic pavement. A maximum of 25 percent RAP binder, by weight of total binder in the mix, may be used in mixes placed in a lower lift (minimum 2" below finished surface). A maximum of 20 percent RAP binder, by weight of total binder in the mix, may be used at all other locations.

When less than or equal to 15 percent RAP binder is used, by weight of total binder in the mix, no testing is required on the RAP binder. When greater than 15 percent RAP binder is used, by weight of total binder in the mix, the RAP binder shall be extracted, recovered, and tested in accordance with the requirements of Arizona Test Method 833. The virgin binder grade shall be modified if necessary to ensure the blend of virgin and RAP binder meets the PG grade specified in the Subsection 416-3.03(B). However, a change of only one virgin PG binder grade (6 °C on either or both the high and low temperatures) will be allowed from that shown in Subsection 416-3.03(B).

416-3.04 Reclaimed Asphalt Pavement (RAP):

RAP shall consist of salvaged, milled, pulverized, broken, or crushed asphalt pavement. If RAP is generated by milling, the minimum removal depth shall be 1-1/2 inches. The source of RAP may be from ADOT or other projects. The contractor shall be responsible for determining the suitability of the RAP for use in the mixture, regardless of its source.

For asphaltic concrete containing less than or equal to 15 percent RAP aggregate, all RAP material shall pass the 1-1/4" sieve. For asphaltic concrete containing greater than 15 percent RAP aggregate, the RAP material shall be processed into uniform coarse and fine stockpiles such that there will be a minimum amount of fines. The use of more than two RAP stockpiles is prohibited. The gradation, when tested in accordance with Arizona Test Method 240, shall meet the following requirements:

Stockpile	Sieve Size	Percent Passing
Coarse	1-1/4 inch	100
	3/8 inch	0-25
Fine	3/4 inch	100
	3/8 inch	75-100

The contractor may propose gradation bands differing from those shown in the table above. The proposal shall be submitted to the Engineer prior to the start of RAP processing. If approved, the required gradation bands will be adjusted accordingly.

RAP shall be stockpiled so that segregation is minimized. When two RAP stockpiles are used, acceptable methods to prevent intermingling of stockpiles shall be provided.

The Engineer reserves the right to reject obviously defective salvaged material or salvaged material that is not representative of the material used in the mix design.

416-3.05 Warm Mix Asphalt Technologies:

Warm Mix Asphalt (WMA) technologies include plant water foaming processes, mineral additives, and chemical additives. WMA technologies must be approved prior to their use in accordance with Materials Policy and Procedure Directive No. 23, "Requirements for the Use of Warm Mix Asphalt (WMA) Technologies in Asphaltic Concrete".

416-4 Mix Design:

Utilizing mineral aggregate and RAP which has been crushed, processed, separated and stockpiled, a mix design shall be formulated and submitted by the contractor to the Engineer. The mineral aggregate and RAP samples used for mix design purposes shall be representative of materials to be used during production.

The mix design shall be based on the mix design criteria and other requirements hereinbefore specified, utilizing asphalt cement and mineral admixture of the type and from the sources proposed for use in the production of asphaltic concrete.

The mix design shall be prepared by or under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. The mix design engineer shall meet the requirements given in ADOT Materials Policy and Procedure Directive No. 4, "Asphaltic Concrete Mix Design Proposals and Submittals". The mix design shall be provided in a format that clearly indicates all the mix design requirements and shall be sealed, signed, and dated by the mix design engineer.

The mix design shall be prepared by a mix design laboratory that has met the requirements of ADOT Materials Policy and Procedure Directive No. 19, "ADOT System for the Evaluation of Testing Laboratories".

The contractor may propose the use of a mix design that has been developed for a previous project. The proposed mix design shall meet the requirements of these specifications. The contractor shall provide evidence that the type and source of bituminous material, the type of mineral admixture, and the source and methods of producing virgin mineral aggregate and RAP have not changed since the formulation of the previous mix design. The contractor shall also provide current test results for all specified characteristics of the mineral aggregate and RAP proposed for use. The Engineer will determine if the previously used mix design is suitable for the intended use and if the previous use of the mix design was satisfactory to the Department. The Engineer will either approve or disapprove the

proposed mix design. Should the Engineer disapprove the use of the previously used mix design, the contractor shall prepare and submit a new mix design proposal in accordance with the requirements of these specifications.

A previously used mix design older than two years from the date it was formulated, sealed, signed, and dated shall not be allowed for use. Once approved for use on a project, a mix design may be used for the duration of that project.

The mix design shall contain as a minimum:

- (1) The name and address of the testing organization and the person responsible for the mix design testing.
- (2) The specific location(s) of the source(s) of mineral aggregate.
- (3) The supplier, refinery, type of asphalt cement and any modifiers including polymers. The source and type of mineral admixture. The percentage of asphalt cement and mineral admixture to be used.
- (4) The anticipated mineral aggregate gradation in each stockpile.
- (5) Mix design gradation. The mix design shall contain the mineral aggregate gradation, and also the gradation with mineral admixture.
- (6) The results of all testing, determinations, etc., such as: specific gravity of each component, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, uncompacted void content (for Special Mix), percent carbonates (if required), immersion compression results (Index of Retained Strength, wet and dry strengths), Marshall stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density.
- (7) Viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used.

When RAP is used in the mixture, the following additional information shall be included in the mix design:

- (1) The specific location(s) of the source(s) of RAP.
- (2) The anticipated RAP gradation, RAP aggregate gradation, and RAP binder content in each stockpile.
- (3) If greater than 15 percent RAP binder is used in the mixture, the results of all tests on the recovered RAP binder, as well as all tests on the blend of virgin binder and recovered RAP binder.
- (4) The percent RAP binder, virgin binder, and total binder in the mixture.

- (5) The composite gradation of virgin and RAP aggregates, with and without mineral admixture. The composite gradation of the virgin aggregate and RAP, with and without mineral admixture.
- (6) The results of all testing, determinations, etc., for the RAP, virgin aggregate, RAP aggregate, and composite of virgin and RAP aggregates as required, such as: specific gravity, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, uncompacted void content (for Special Mix), and percent carbonates.
- (7) The viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges for the blended binder, if greater than 15 percent RAP binder is used in the mixture, as well as the actual laboratory mixing and compaction temperatures used.

When Warm Mix Asphalt (WMA) technologies are used in the mixture, the additional mix design requirements specified in Materials Policy and Procedure Directive No. 23, "Requirements for the Use of Warm Mix Asphalt (WMA) Technologies in Asphaltic Concrete", shall also be included in the mix design.

Test results used in the formulation of the mix design shall be from testing performed no earlier than 45 days prior to the date the mix design is signed by the mix design engineer. Historical abrasion values may be supplied on sources provided the testing was conducted within the past two years.

The mix design shall be submitted to the Engineer under a cover letter signed by an authorized representative of the contractor.

A copy of the mix design and representative samples of the materials used in the mix design shall be submitted to the Engineer for calibration of the ignition furnace, and for the determination of sand equivalent and fractured coarse aggregate particles. When Special Mix is used, the uncompacted void content shall also be determined. Approximately 300 pounds of virgin mineral aggregate (proportional to the mix design gradation), three gallons of asphalt cement, and one gallon of mineral admixture shall be submitted. When RAP is used, a minimum of 40 pounds of representative RAP material and a minimum of 10 pounds of solvent-extracted RAP aggregate, per AASHTO T 164, Method A, shall be submitted. If RAP is fractionated, the RAP and RAP aggregate from each stockpile shall be kept separate. The Engineer shall witness the sampling of the virgin mineral aggregate and RAP. The mix design and samples shall be submitted to the Engineer at least five working days prior to the start of asphaltic concrete production.

The sand equivalent, fractured coarse aggregate particles, and (for Special Mix) uncompacted void content shall meet the requirements specified in Subsection 416-3.01. Additional testing of the uncrushed and crushed fine aggregate for uncompacted void content will be required if the method of producing either fine aggregate is modified.

If the mineral aggregate fails to meet the requirements specified herein, asphaltic concrete production shall not commence, and the contractor shall either submit a revised mix design which is representative of the materials produced or correct the deficiencies in the aggregate stockpiles.

The Engineer will review the mix design to assure that it contains all required information. If it does not, it will be returned within two working days of receipt of all samples and mix design information, for further action and resubmission by the contractor.

If the contractor elects to change its source(s) of mineral aggregate or RAP, or adds or deletes the use of a stockpile(s) regardless of source, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

If changes are made in the source or type of bituminous material, or the type of mineral admixture, the contractor shall provide verification testing results. Verification testing shall be performed at the original mix design asphalt content using the original mineral aggregate and RAP (if used), the proposed bituminous material, and/or the proposed mineral admixture. Three specimens shall be fabricated and tested for bulk density, maximum theoretical density, and effective voids. The percent effective voids must be within ± 0.2 of the percent effective voids in the original design and also be within the current effective voids mix design specification limits. Verification testing results shall not replace target values shown in the original mix design. All target values from the original design shall be used in future production with the exception of any self-directed target value changes that are requested. The verification process does not ensure that the contractor can meet the target values during production.

In addition to the verification testing specified above, verification testing for immersion compression may also be required. If there is a change in the type of mineral admixture, immersion compression testing is required. If there is a change in the source or type of bituminous material, immersion compression testing is required if the Index of Retained Strength of the original mix design is less than ten percentage points greater than the specified minimum, or if the Wet Strength is less than 100 psi greater than the specified minimum.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing and acknowledged by the Engineer prior to start of production for a lot. Self-directed target changes shall meet contract requirements for mix design criteria and grading limits.

MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (sieve size): 3/8 inch No. 8 No. 40 No. 200	$\pm 4\%$ from mix design target value $\pm 4\%$ from mix design target value $\pm 2\%$ from mix design target value $\pm 0.5\%$ from mix design target value
Asphalt Cement Content	$\pm 0.2\%$ from mix design target value

Effective Voids	None
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The contractor may propose target changes to the approved mix design for the Engineer's approval. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and grading limits. For acceptance purposes, target changes will not be retroactive.

In no case shall the approval of mix design changes relieve the contractor of the responsibility for the results obtained by the use of such approved changes.

Should a mix design prove unsatisfactory to the contractor during production, the contractor shall furnish the Engineer with a revised mix design. For acceptance purposes, the revised mix design will not be retroactive.

The contractor shall not change its methods of crushing, screening, washing, or stockpiling from those used during production of material used for mix design purposes without approval of the Engineer or without preparing a new mix design.

416-5 Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C). At the weekly meeting, the contractor shall be prepared to explain and discuss how the following processes will be employed.

- (a) Aggregate production, including crusher methods, pit extraction, and washing.
- (b) RAP production, including milling, crushing, screening, and handling methods.
- (c) Stockpile management, including stacking methods, separation technique, plant feed technique, stockpile pad thickness, and segregation prevention.
- (d) Proportioning and plant control, including plant scale calibration, mix temperature control, storing method, and addition of admixture.
- (e) Transporting and placing, including hauling distance and temperature control, segregation and non-uniform placement control, and joint placement and technique.
- (f) Compaction, including types and weight of rollers, establishing and monitoring of roller patterns, and temperature controls.

The contractor shall obtain samples and perform the tests specified in the following table:

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	TEST METHOD	SAMPLING POINT	MINIMUM TESTING FREQUENCY
Virgin Mineral Aggregate			
Gradation	ARIZ 201	Crusher Belt	1 per stockpile per day

Sand Equivalent	AASHTO T 176	or Stockpile	1 per 2000 Tons of total virgin aggregate (1)
Fractured Coarse Aggregate Particles	ARIZ 212		
Uncompacted Void Content (2)	ARIZ 247		
Reclaimed Asphalt Pavement			
Gradation, Moisture Content, and Binder Content	ARIZ 428 (Appendix A)	Crusher Belt or Stockpile	1 per stockpile per day
RAP Aggregate			
Gradation	ARIZ 201	Crusher Belt or Stockpile	1 per stockpile per day
Fractured Coarse Aggregate Particles	ARIZ 212		1 per stockpile every other day
Asphaltic Concrete			
Gradation	ARIZ 201 or 427 (428 for RAP mixes)	Cold Feed, Hot Bins, Roadway, or Plant	1 per 1000 Tons
Asphalt Content	ARIZ 421, 427 (428 for RAP mixes), or other approved methods	Roadway or Plant	1 per 1000 Tons
Voids	ARIZ 410, 415, 417, 424		1 per 1000 Tons each day. Maximum of 4 per day.
Compaction	ARIZ 412	Roadway	1 per 300 tons
Notes:			
(1) Prior to the completion of the mix design, quality control tests on mineral aggregate shall be performed based on the anticipated percent use of each stockpile. Samples taken from individual stockpiles may be composited prior to performing the required tests, or testing may be performed on material from each stockpile and the composite test result for each required test determined mathematically.			
(2) For Special Mix.			

The contractor shall be responsible for the proportioning of all materials, for the hauling, placing, loading, spreading, and finishing of asphaltic concrete and for the applying of bituminous material, such as tack coats, prime coats, and provisional seals, all in accordance with the appropriate portions of the specifications.

The asphaltic concrete hot plant shall conform to the requirements of Section 403 of the Specifications.

During production, the percent RAP aggregate and percent RAP binder shall not exceed the maximum allowed in Subsections 416-3.01(C), 416-3.03(C), and 416-3.04. In addition, the percent RAP material shall be maintained to within plus 2 percent and minus 5 percent of the mix design value(s). When two RAP stockpiles are used, this tolerance shall apply to the total percent RAP material in the mixture, as well as the percent RAP material from each stockpile.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the drier shall not exceed 325 °F unless a higher temperature is recommended in writing by the asphalt binder supplier and approved by the Engineer.

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

Self-propelled paving machines shall spread the mixture within the specified tolerances, without segregation or tearing, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which shall distribute the mixture uniformly in front of adjustable screeds.

Pavers shall be equipped with a screed for the full width being paved, heated if necessary, and capable of spreading and finishing all courses of asphaltic concrete.

Pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope.

Failure of the control system to function properly shall be cause for the suspension of the placing of asphaltic concrete.

The base or subgrade upon which asphaltic concrete is to be placed shall be prepared and maintained in a firm condition until asphaltic concrete is placed. It shall not be frozen or excessively wet.

At any time, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors and other equipment surfaces shall be treated when necessary with a release agent approved by the Engineer in order to prevent the sticking of asphaltic concrete. Release agents which degrade, dissolve, or in any way damage the bituminous material shall not be used. Diesel fuel shall not be used as a release agent.

Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of any immediate underlying course.

When surfacing courses are placed on 10 foot or wider shoulders which are to receive rumble strips, the contractor shall place any longitudinal joints approximately one foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the centerline between two adjacent lanes. Joints shall be formed by a slope shoe or hot-lapped, and shall result in an even, uniform surface.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth of the lift and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

All locations where plate samples are taken from the roadway shall be immediately repaired by the contractor utilizing hot asphaltic concrete. All holes where cores are taken shall be repaired within 48 hours after coring using a material approved by the Engineer. All holes shall be in a dry condition prior to repair. The patching material shall be thoroughly compacted in the holes by the contractor.

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked in accordance with the requirements of Section 404. The cleaning of the surface, the tacking of the surface, and the type of bituminous material used shall be acceptable to the Engineer. The amount of bituminous material used shall be as directed by the Engineer.

A light coat of bituminous material shall be applied to edges or vertical surfaces against which asphaltic concrete is to be placed.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent. The moisture content will be determined in accordance with Arizona Test Method 406.

When Warm Mix Asphalt (WMA) technologies are used, the contractor shall comply with the manufacturer's recommendations for incorporating additives and WMA technologies into the mixture. The contractor shall comply with the manufacturer's recommendations regarding transporting, storage, and delivery of additives and water foaming processes. The contractor shall maintain a copy of the manufacturer's recommendations on file at the asphalt mixing plant and make those recommendations available for reference while using WMA technologies.

416-7 Acceptance:

416-7.01 General:

In addition to the random acceptance samples taken from each lot, the Engineer may sample and reject material which appears to be defective. Such rejected material shall not be used in the work. The results of tests run on rejected material will not be included with the lot acceptance tests.

Acceptance will be on the basis of the following:

- Sand Equivalent
- Fractured Coarse Aggregate Particles
- Uncompacted void Content (for Special Mix)
- Material Spread
- Gradation
- Asphalt Cement Content
- Effective Voids
- Stability
- Compaction
- Smoothness

416-7.02 Sand Equivalent, Fractured Coarse Aggregate Particles, and Uncompacted Void Content of Mineral Aggregate:

During asphaltic concrete production, the Engineer shall obtain and test samples of material for the determination of the sand equivalent and fractured coarse aggregate particles. When Special Mix is used, the uncompacted void content shall also be determined. When RAP is used in the mixture, the sand equivalent and uncompacted void content shall be determined on the composite of virgin aggregates only. Samples shall be obtained from the cold feed belt prior to the addition of mineral admixture, or from the stockpiles when sampling from the cold feed belt is not possible.

When RAP is used in the mixture, the material for determining the fractured coarse aggregate particles shall come from an asphaltic concrete sample taken and tested in accordance with Arizona Test Method 428, as specified in Subsection

416-7.04(A). However, if the Engineer determines that excessive breakdown of the aggregate has occurred due to the use of the ignition furnace, the fractured coarse aggregate particles testing shall be performed on the combination of RAP aggregate, as obtained in accordance with Arizona Test Method 428, and virgin mineral aggregate.

Virgin mineral aggregate will be acceptable for sand equivalent if it meets the minimum requirements specified in Subsection 416-3.01.

The fractured coarse aggregate particles shall meet the minimum requirements specified in Subsection 416-3.01.

For Special Mix, the uncompacted void content shall meet the minimum requirements specified in Subsection 416-3.01. Additional testing of the uncrushed and crushed fine aggregate for uncompacted void content will be required if the method of producing either fine aggregate is modified.

If the mineral aggregate fails to meet the requirements specified herein, operations shall cease and the contractor shall have the option of submitting a revised mix design conforming to the requirements of Subsection 416-4 or correcting deficiencies in the aggregate stockpiles.

416-7.03 Material Spread:

A spread lot shall be considered to be one-half shift of production. Lots encompassing more than one project shall be separated in accordance with Subsection 416-9(D).

The contractor shall record information pertaining to each spread lot on forms provided by the Engineer. Information shall include the project number, date and period of time that each spread lot was placed, the spread lot number, beginning and ending station, the plans thickness, and tons placed in each lot. Completed spread lot forms shall be signed by the contractor and given to the Engineer at the end of each shift.

The Engineer will calculate the quantity required in each spread lot using the mix design bulk density unless a request is made by the contractor to use a production bulk density. If a request is made to use production bulk density, the first three non-rejected lots following the test lot will be used to determine the average production bulk density. All lots placed prior to establishing the average production bulk density shall be calculated using the mix design bulk density. For each new mix design used on the project, a new production bulk density may be requested by the contractor. In addition, if conditions warrant during asphalt production, the contractor may request establishment of a new average production bulk density. A request All requests to use a production bulk density shall be made in writing and approved by the Engineer prior to use. The same procedure will be used for determining average production bulk density in all cases. Changes to the bulk density for calculating spread quantities will shall not be retroactive.

The calculated quantity required in each spread lot will be compared to the actual quantity placed. A lot will be considered to be acceptable, with a zero pay factor, if the actual quantity placed varies by no more than -2.0 to +5.0 percent from the required quantity.

If the quantity in a lot is found to vary from the required quantity by -2.1 to -12.0 percent, the appropriate pay factor will be determined in accordance with Table 416-1. This pay factor will be utilized in determining the pay adjustment as outlined in Subsection 416-9.

416-7.04 Gradation, Asphalt Cement Content, Effective Voids, and Stability:

(A) General:

A mixture properties lot shall be considered to be one shift's production. In the event a shift's production is less than 1200 tons, multiple shifts may be combined to form a lot. When a lot consists of production from more than one shift, the following conditions apply: at least one sample shall be taken each shift, at least one sample shall be taken every 500 tons, and no mix design or target value changes shall be made within the lot. If changes are made in the mix design or target values, new lots will be established.

Four samples of the asphaltic concrete shall be taken for each lot by the contractor, under the observation of the Engineer, at random locations designated by the Engineer. Samples will be taken in accordance with the requirements of Section 2 or 3 of Arizona Test Method 104 and delivered to the Engineer immediately after being taken. The minimum weight of the sample shall be 75 pounds. The Engineer will split the sample and save one-half for 15 days after written notification to the contractor of test results for that lot has been made. The material will be tested by the Engineer for the following properties:

Test Property	Test Method
Asphalt Cement Content	Arizona Test Method 427 (428 for RAP mixes) (See Notes 1 and 2 below)
Gradation	
Marshall Density and Stability	Arizona Test Method 410
Maximum Theoretical Density	Arizona Test Method 417
Effective Voids	Arizona Test Method 424
Notes: (1) A new calibration of the ignition furnace shall be performed for each mix design, and at any other time the Engineer directs. (2) Ignition furnace results will be corrected for asphalt cement content in accordance with Subsection 416-7.04(B) or (C) as required.	

Acceptance testing results will be furnished to the contractor within four working days of receipt of samples by the Engineer.

A mixture-properties lot placed with an average stability below 2,500 pounds for base mixes, or 1,750 pounds for 1/2 or 3/4 inch mixes shall be rejected, and shall be subject to an engineering analysis of anticipated performance in accordance with Subsection 416-9(E). Production shall cease until the contractor proposes a corrective

action the Engineer finds acceptable. If the Engineer rejects the proposed corrective action, the contractor shall submit a revised mix design.

The target values for gradation, asphalt cement content, and effective voids are given in the contractor's mix design. The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each of the measured characteristics are as follows:

Measured Characteristics	LL (Note 1)	UL (Note 1)
Gradation (Sieve size):		
3/8 inch (Note 2)	TV - 6.0	TV + 6.0
No. 8	TV - 6.0	TV + 6.0
No. 40	TV - 5.0	TV + 5.0
No. 200	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.50	TV + 0.50
Effective Voids	TV - 2.0	TV + 1.5
Notes:		
(1) The limits are used in the statistical calculations for Quality Index. Acceptance is controlled by the variability of the produced material and every effort should be made to strive for the applicable target value (TV).		
(2) In the case of the 3/8 inch sieve requirement, for the base mix only, the lower limit shall be the target value minus 8.0, and the upper limit shall be the target value plus 8.0.		

The Engineer will determine the PT for each measured characteristic in accordance with Subsection 416-9(I), and utilizing Table 416-1 will determine the pay factor for each measured characteristic.

In the event the contractor elects to question the mixture property test results, the contractor may request referee testing in accordance with Subsection 416-9 (J).

(B) Ignition Furnace Correction for Non-RAP Mixes:

For plants providing asphaltic concrete exclusively for the project, the difference between the asphalt cement content as measured by ignition furnace testing and the actual asphalt cement content shall be determined by the Engineer for each of the first five lots of asphaltic concrete produced for each mix design. If there are less than five lots for the mix design, the total number of available lots shall be used. If approved by the Engineer, a plant may be considered exclusive to the project if an asphalt cement tank is dedicated for the shift of asphaltic concrete production. The determination of the actual asphalt cement content may include weighing of asphalt cement deliveries, invoice quantities, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted materials. If a computerized mass-flow meter is used, documentation of its calibration shall be submitted to the Engineer prior to asphaltic concrete production. At any time during asphaltic concrete production, the Engineer may require that a new calibration of the mass-flow meter be performed. If the

average difference exceeds ± 0.10 percent asphalt cement content between the asphalt cement content measured by ignition furnace testing and the actual asphalt cement content, the contractor may request that a correction to the asphalt cement content by ignition furnace testing be made. The contractor must make such a request in writing within two working days after receiving the test results for the fifth lot of asphaltic concrete production. If referee testing is performed on a lot of asphaltic concrete for which a correction, based on the actual asphalt cement content, was made to the asphalt cement content by ignition furnace testing, referee testing shall not apply to the determination of asphalt cement content. The correction, once documented and approved by the Engineer, shall be applied to test results from the beginning of asphaltic concrete production through the remainder of asphaltic concrete production using that mix design; however, a new correction may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances. If the contractor submits a new mix design, a new correction must be established and applied as specified above. For plants not providing asphaltic concrete exclusively for this project, no correction will be made to asphalt cement content values measured by ignition furnace testing.

(C) Ignition Furnace Correction for Mixes Containing RAP:

For mixes containing RAP, an asphalt cement tank shall be dedicated to the project for each shift of asphaltic concrete production. The difference between the asphalt cement content as measured by ignition furnace testing and the actual asphalt cement content shall be determined by the Engineer for each of the first five lots of asphaltic concrete produced for each mix design. If there are less than five lots for the mix design, the total number of available lots shall be used. The actual asphalt cement content shall be determined by adding the virgin asphalt cement content to the RAP binder content determined in Subsection 416-7.04(D), both expressed as a percent of the total mix. The determination of the virgin asphalt cement content may include weighing of asphalt cement deliveries, invoice quantities, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted materials. If a computerized mass-flow meter is used, documentation of its calibration shall be submitted to the Engineer prior to asphaltic concrete production. At any time during asphaltic concrete production, the Engineer may require that a new calibration of the mass-flow meter be performed. If the average difference exceeds ± 0.10 percent asphalt cement content between the asphalt cement content measured by ignition furnace testing and the actual asphalt cement content, a correction to the asphalt cement content by ignition furnace testing shall be made. The correction shall be applied to test results from the beginning of asphaltic concrete production through the remainder of asphaltic concrete production using that mix design; however, a new correction may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances. If the contractor submits a new mix design, a new correction must be established and applied as specified above. Referee testing shall not apply to the determination of asphalt cement content for asphaltic concrete containing RAP.

(D) RAP Binder Content:

(1) General:

During asphaltic concrete production, the Engineer shall obtain and test samples of the RAP material to determine the RAP binder content in each stockpile at a minimum frequency of one sample per lot. The RAP will be tested by the Engineer for asphalt binder content in accordance with Arizona Test Method 428. When more than one RAP sample is tested for a given lot and stockpile, the average of the results shall be used.

(2) RAP Binder Content Correction Factor:

A RAP binder correction factor shall be determined for each RAP stockpile used in the mixture.

At the start of asphaltic concrete production, the first two samples of RAP material from each stockpile will be split and tested for asphalt binder content; one split is tested in accordance with Arizona Test Method 428 (ignition furnace) and the other split is tested in accordance with AASHTO T 164 (solvent extraction). A RAP binder correction factor will be determined by subtracting the average ignition furnace result from the average solvent extraction result. The appropriate correction factor shall be added to each asphalt binder test result determined on the material from each RAP stockpile in accordance with Arizona Test Method 428 to determine the RAP binder content. At the discretion of the Engineer, the correction factor may be determined prior to the start of asphaltic concrete production provided representative RAP samples are available. A new correction factor may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances.

416-7.05 Compaction:

(A) Courses 1 1/2 Inches or Less in Nominal Thickness:

(1) General Requirements:

Asphaltic concrete shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 degrees F and the ambient temperature at the beginning of placement is at least 65 degrees F and rising. The placement shall be stopped when the ambient temperature is 70 degrees F or less and falling.

When Warm Mix Asphalt (WMA) technologies are not used in the mixture, asphaltic concrete immediately behind the laydown machine shall be a minimum of 275 degrees F.

When Warm Mix Asphalt (WMA) technologies are used in the mixture, the recommended temperature range for compaction during production shall be shown on the mix design and shall be approved by the Engineer.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

(2) Equipment:

Compacting and smoothing shall be accomplished by the use of self-propelled equipment. Compactors shall be pneumatic-tired and/or steel wheel.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Steel wheel compactors shall weigh not less than eight tons.

Pneumatic-tired compactors shall be the oscillating type with at least seven pneumatic tires of equal size and diameter. Wobble-wheel compactors will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be capable of being inflated to 90 pounds per square inch and maintained so that the air pressure will not vary more than five pounds per square inch from the designated pressure. Pneumatic-tired compactors shall be constructed so that the total weight of the compactor will be varied to produce an operating weight per tire of not less than 5,000 pounds. Pneumatic-tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

(3) Rolling Method Procedure:

Compaction shall consist of an established sequence of coverage using specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used, and the number of coverages required shall be as follows:

Rolling Sequence	Type of Compactor		No. of Coverages	
	Option No. 1	Option No. 2	Option No.1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2- 4*
Finish	Static Steel	Static Steel	1-3	1-3
* Based on the roller pattern which exhibits the best performance.				

The Engineer shall select the option for compaction and, when pneumatic-tired compactors are used, will designate the tire pressure.

One pneumatic-tired roller shall be furnished for each 300 tons of asphaltic concrete per hour.

Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F.

Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 degrees F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified, and with the number of coverages of the compactors as specified.

(B) Courses Greater than 1 1/2 Inches in Nominal Thickness:

Compaction control shall be the responsibility of the contractor. The number and types of rollers shall be the contractor's responsibility and shall be sufficient to meet these requirements.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

A compaction lot shall be identical to the mixture properties lot described in Subsection 416-7.04. Lots encompassing more than one project shall be separated in accordance with Subsection 416-9 (D). Each lot shall be tested for acceptance.

Twenty cores shall be taken for each lot by the contractor, under the observation of the Engineer. The Engineer will designate ten random locations within the lot, and the contractor shall take two cores at each location; however, if more than one shift constitutes a lot, two cores shall be taken from a minimum of two random locations each shift, or as directed by the Engineer. The Engineer will save one core from each location for 15 days after written notification to the contractor of test results for the lot has been made. Randomly selected locations will be determined to the nearest one-half foot in the transverse direction and to the nearest foot in the longitudinal direction of the pavement course; however, the outside one foot of the unconfined pavement course will be excluded from testing as shown in Materials ADOT Policy and Procedure Directive (P.P.D.) No. 18, "Determining Sample Times and Locations for End Product Asphaltic Concrete". P.P.D. No. 18 also addresses areas to be excluded relative to longitudinal joints. Areas excluded from testing will be compacted in accordance with Subsection 416-7.05(A). Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104. Cores shall be a minimum of four inches in diameter and shall be taken not later than two working days after placement of the asphaltic concrete. The cores shall be delivered to the Engineer immediately upon being taken. The bulk density of each core will be determined by the Engineer in accordance with the requirements of Arizona Test Method 415. The test results will be furnished to the contractor within four working days of receipt of cores by the Engineer. In areas where more than one lift is placed in the same lot, coring shall be accomplished through the full depth of the lifts after the final lift is placed, and the compaction density shall be based on the full depth of the lifts.

The target value for compaction shall be 7.0 percent in-place air voids. In-place air voids shall be determined in accordance with Arizona Test Method 424. The maximum theoretical density used in the determination of air voids will be the average of the four maximum theoretical densities determined for the lot in Subsection 416-7.04.

The Upper Limit (UL) is 9.0 percent in-place air voids and the Lower Limit (LL) is 3.5 percent in-place air voids. The Engineer will determine the PT for compaction in accordance with Subsection 416-9(I), and utilizing Table 416-1 will determine the compaction pay factor.

In the event the contractor elects to question the core test results, the contractor may request referee testing in accordance with Subsection 416-9(J).

416-7.06 Smoothness and Surface Tolerances:

Asphaltic concrete shall be compacted as required, smooth and true to the required lines, grades, and dimensions.

The Special Provisions may require the smoothness of the final pavement surface to be tested in accordance with Subsection 109.13.

Regardless of whether testing in accordance with Subsection 109.13 is specified or not, the following requirements shall be met:

- (1) The surface of the final lift of asphaltic concrete placed under this section of the specifications shall be tested and shall not vary by more than 1/8 inch from the lower edge of a ten-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints.
- (2) The surface of any lift of asphaltic concrete placed under this section of the specifications, other than the final lift, shall be tested and shall not vary by more than 1/4 inch from the lower edge of a ten-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints.
- (3) All deviations exceeding the specified tolerances above shall be corrected by the contractor, to the satisfaction of the Engineer.

416-8 Method of Measurement:

(A) Asphaltic Concrete:

Asphaltic concrete will be measured by the ton for the asphaltic concrete actually used, which will include the weight of mineral aggregate, asphalt cement, and mineral admixture. Measurement will include any quantity used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

(B) Asphalt Cement:

(1) Non-RAP Mixes:

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsections 416-7.04(A) and (B) for each lot of asphaltic concrete accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. If the contractor has requested referee testing, the average asphalt cement content will come from the independent testing laboratory results unless a correction, based on the actual asphalt cement content, was made to the ignition furnace test value as allowed in Subsection 416-7.04(B). If a correction, based on the actual asphalt cement content, was made to the ignition furnace test value, the average asphalt cement content determined from the Department's acceptance testing will be used. At the discretion of the Engineer, asphalt cement may be measured by invoice quantities, adjusted as necessary for waste. Waste generated from startup of the asphalt plant will be considered to have a binder content of 3.0 percent. In no case shall the measured amount of asphalt cement for payment be greater than the total of the invoice quantities, adjusted for waste.

(2) Mixes Containing RAP:

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsections 416-7.04(A) and (C) for each lot of asphaltic concrete accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. At the discretion of the Engineer, asphalt cement may be measured by adding invoice quantities to the RAP binder used, adjusted as necessary for waste. RAP binder used shall be determined by multiplying the RAP binder content determined in Subsection 416-7.04(D) by the number of tons of dry RAP material used in that lot. Waste generated from startup of the asphalt plant will be considered to have a binder content of 3.0 percent. In no case shall the measured amount of asphalt cement for payment be greater than the total of the invoice quantities plus the RAP binder as determined above, adjusted for waste.

(C) Mineral Admixture:

Mineral admixture will be measured by the ton for the mineral admixture actually used in accordance with Subsection 403-2.

416-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price adjusted by the appropriate pay factors as hereinafter provided.

When Warm Mix Asphalt (WMA) technologies are used in the mixture, no separate payment will be made for WMA additives or technologies, necessary hot plant modifications, or other associated costs.

For the purpose of determining acceptability and appropriate pay factors, each unit of asphaltic concrete will be included in three separate lots: a "spread lot," a

"mixture-properties lot," and a "compaction lot." The total unit price for any unit of accepted asphaltic concrete will be the contract unit price, adjusted by the applicable spread lot pay factor, mixture-properties lot pay factor, and compaction lot pay factor.

The contractor may request to place the first lot of each mix type as a test strip. Requests to place a test strip shall be made in writing and acknowledged by the Engineer prior to start of production. A test strip shall be limited to 1,000 tons and may only be placed on shoulders, ramps, cross roads, or other areas approved by the Engineer. A test strip shall be excluded from the mixture properties lot pay factor and the compaction lot pay factor; however, all other provisions of Subsection 416-9 shall still apply to such areas.

The Engineer may exclude asphaltic concrete from the spread lot and from the spread lot pay factor calculations if the Engineer determines that the proposed use of the material or the existing surface conditions are not conducive to the use of spread lots.

The Engineer may exclude certain locations from the mixture properties lot and/or the compaction lot and from the random sampling used in determining the mixture properties lot pay factor and/or the compaction lot pay factor should the Engineer determine that the location of the work precludes normal construction operations.

(A) Spread Lot Pay Factor:

The spread lot pay factor will be determined in accordance with Subsection 416-7.03. If the quantity in a spread lot is found to vary by more than + 5.0 percent from the required quantity, no payment will be made for the material which exceeds + 5.0 percent, including asphalt cement and mineral admixture. If the quantity is found to vary by more than - 12.0 percent from the required quantity, the spread lot will be rejected.

(B) Mixture-Properties Lot Pay Factor:

The mixture properties lot pay factor shall be determined in accordance with the following procedure:

- (1) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids shall be determined as set forth in Subsection 416-7.04.
- (2) A single pay factor shall be determined for Gradation and Asphalt Cement Content. That pay factor shall be the lowest pay factor for the individual measured characteristics for Gradation and Asphalt Cement Content.
- (3) If no individual PT value in (1) above is less than 50, the mixture properties lot pay factor shall be the sum of the pay factor determined in (2) above and the Effective Voids pay factor. The negative pay factor for mixture properties shall not exceed \$3.00 per ton. If any individual PT value is less than 50, the lot is in reject and the provisions in Subsection 416-9(E) shall apply.

(C) Compaction Lot Pay Factor:

The compaction lot pay factor shall be determined as set forth in Subsection 416-7.05(B).

(D) Determination of Lot Pay Factors on Contracts Involving Multiple Projects:

When more than one project is included in a single contract, placement during a shift or half shift of production may encompass more than one project. In such case, the applicable spread lot pay factor, mixture-properties lot pay factor, and compaction lot pay factor for each project shall be determined as follows:

- (1) Spread lot pay factors will be determined separately for each project utilizing the procedure set forth in Subsection 416-7.03.
- (2) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids will be determined from the results of the random samples taken and tested in accordance with Subsection 416-7.04, regardless of which project(s) the samples fall within.
- (3) PT values and pay factors for compaction, for those areas subject to Subsection 416-7.05(B), shall be determined from separate sets of core samples for each project utilizing the procedure set forth in that Subsection.
- (4) The mixture-properties lot pay factor shall be determined separately for each project in accordance with Subsection 416-9(B), utilizing the individual pay factors determined in (2) above.
- (5) The compaction lot pay factor shall be determined separately for each project in accordance with Subsection 416-9(C), utilizing the pay factor determined in (3) above.

(E) Acceptability:

Asphaltic concrete included in any mixture properties lot possessing an individual PT value lower than 50 for Gradation, Asphalt Cement Content, or Effective Voids will be rejected. Asphaltic concrete included in any compaction lot possessing a PT value lower than 50 will be rejected.

Within 15 days after receiving notice that a spread lot, mixture properties lot, or compaction lot of asphaltic concrete has been rejected by the Engineer, the contractor may submit a written proposal to accept the material in place at the applicable maximum negative pay factor(s). Maximum negative pay factors are defined as a minus \$1.00 per ton for spread lots, minus \$5.00 per ton for compaction lots, minus \$3.00 per ton for mixture properties lots in reject for gradation only, minus \$5.00 per ton for mixture properties lots in reject for asphalt cement content and/or effective voids only, and minus \$5.00 per ton for mixture properties lots in reject for asphalt cement content and/or effective voids and also gradation. Positive mixture properties lot pay factors become zero when the compaction lot is in reject and the material is allowed to be left in place. In addition, for any mixture properties lot that

is in reject due to asphalt cement content but allowed to remain in place, payment shall not be made for asphalt cement quantities in excess of the upper limit (UL) as determined in Subsection 416-7.04(A).

The proposal shall contain an engineering analysis of the anticipated performance of the asphaltic concrete if left in place. The engineering analysis shall also detail any proposed corrective action, and the anticipated effect of such corrective action on the performance. The engineering analysis shall be performed by an independent professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected mixture properties lot or a rejected compaction lot is submitted for referee testing by the contractor, the 15 days allowed to prepare an engineering analysis will begin upon notification of referee test results.

Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is not accepted, the asphaltic concrete shall be removed at no additional cost to the Department and replaced with asphaltic concrete meeting the requirements of these specifications. If the proposal is accepted, the asphaltic concrete shall remain in place at the applicable maximum negative pay factor(s), and any necessary corrective action shall be performed at no additional cost to the Department.

The Department reserves the right to suspend the work should any of the following conditions occur:

- (1) The occurrence of two or more rejected lots within any ten consecutive production lots.
- (2) The occurrence of three consecutive negative mixture properties lot pay factors or three consecutive negative compaction lot pay factors.
- (3) The occurrence of five or more pay factors that are negative either for a mixture properties lot or for a compaction lot within any ten consecutive production lots.

If the Department elects to suspend the work for any of these conditions, the contractor shall either submit a revised mix design in accordance with Subsection 416-4, or submit for the Engineer's approval a written engineering analysis. The engineering analysis shall detail the course of action necessary to correct deficiencies in the contractor's present production methods such that further production can be accomplished without excessive amounts of asphaltic concrete in penalty or rejection. If approved by the Engineer, the revised mix design, or the course of action proposed in the engineering analysis, shall be implemented, and the work may continue. Costs or delays due to the provisions of this subsection are not compensable.

(F) Asphalt Cement:

(1) Non-RAP Mixes:

Payment for asphalt cement will be made by the ton. Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01.

(2) Mixes Containing RAP:

When RAP is used in the mixture, payment for asphalt cement will be made by the ton for the total asphalt cement as determined in Subsection 416-8(B)(2). Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01 for the virgin binder only.

(G) Mineral Admixture:

Mineral admixture will be paid for at the predetermined price established in the Bidding Schedule.

(H) Smoothness:

When required in the Special Provisions, payment for smoothness shall be made in accordance with the requirements of Subsection 109.13.

(I) Statistical Acceptance:

The "Total Percentage of Lot Within UL and LL (PT)" shall be determined in accordance with Subsection 109.11 of the Specifications.

Pay Factors (PF) shall be determined by entering Table 416-1 with PT.

TABLE 416-1 PAY FACTORS					
Material Spread		Mixture Properties and Compaction			
Negative Variance %	Pay Factor (Dollars per Ton)	PT	Pay Factors(Dollars per Ton)		
			Gradation and Asphalt Cement Content	Effective Voids	Compaction
2.1 - 3.0	- 0.10	100	0.00	+ 2.00	+ 2.00
3.1 - 4.0	- 0.20	95 - 99	0.00	+ 0.50	+ 0.50
4.1 - 5.0	- 0.30	90 - 94	0.00	0.00	0.00
5.1 - 6.0	- 0.40	85 - 89	0.00	- 0.25	- 0.25
6.1 - 7.0	- 0.50	80 - 84	- 0.25	- 0.50	- 0.50
7.1 - 8.0	- 0.60	75 - 79	- 0.50	- 0.75	- 0.75
8.1 - 9.0	- 0.70	70 - 74	- 0.75	- 1.00	- 1.00
9.1 - 10.0	- 0.80	65 - 69	- 1.00	- 1.25	- 1.25
10.1 - 11.0	- 0.90	60 - 64	- 1.50	- 1.50	- 1.75
11.1 - 12.0	- 1.00	55 - 59	- 2.00	- 2.00	- 2.25
More than 12.0	Reject	50 - 54	- 2.50	- 2.50	- 3.00
See Subsections		Less than	Reject-See Subsection 416-9 (E)		

(J) Referee Testing:**(1) Referee Testing Performed for Mixture Properties Only:**

Within 15 days after written notification to the contractor of test results for a particular mixture properties lot, the contractor may make a written request for referee testing. The referee testing shall be performed by an independent approved laboratory designated by the Department. The testing of the samples will be performed by the independent testing laboratory without knowledge of the specific project conditions such as the identity of the contractor or mix design laboratory, the test results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for the following properties:

Test Property	Test Method
Asphalt Cement Content (See Note 1 below)	Arizona Test Method 427 (428 for RAP mixes)
Gradation	
Marshall Density and Stability	Arizona Test Method 410
Maximum Theoretical Density	Arizona Test Method 417
Effective Voids	Arizona Test Method 424
<p>Note:</p> <p>(1) If a correction to the asphalt cement content by ignition furnace testing is made in accordance with Subsection 416-7.04(B), or if RAP is used in the mixture, the asphalt cement content shall not be subject to referee testing.</p>	

The results of the referee testing will be binding on both the contractor and the Department.

Using the referee testing results, the Engineer will determine new PT's for all characteristics, with the exception of asphalt cement content if a correction to the ignition furnace value was made as specified in Subsection 416-7.04(B), or if RAP is used in the mixture.

When referee testing is performed on a mixture properties lot, the referee test result for the average maximum theoretical density will be used to determine a new PT for compaction.

The Department will pay for the referee testing; however, if the combined pay factor of the lot (Mixture Properties plus Compaction) does not improve or is reduced, or if either the mixture properties lot or compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties of that particular lot.

(2) Referee Testing Performed for Compaction Only:

Within 15 days after written notification to the contractor of test results for a particular compaction lot, the contractor may make a written request for referee testing. The bulk density of each of the cores previously saved will be determined in accordance with the requirements of Arizona Test Method 415 by an independent testing laboratory designated by the Department. The testing of the cores will be performed by the independent testing laboratory without knowledge of the specific project conditions, such as the identity of the contractor or mix design laboratory, or the test results by the Department. The percent air voids will be determined in accordance with Arizona Test Method 424. The maximum theoretical density used in the determination of air voids will be the average of the four maximum theoretical densities determined for the lot in Subsection 416-7.04.

The results of the referee testing will be binding on both the contractor and the Department.

When referee testing is performed on the compaction lot, the Engineer will determine a new PT for compaction using the referee testing results.

The Department will pay for the referee testing; however, if the pay factor of the compaction lot does not improve or is reduced, or the compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete will be reduced by the amount of the cost of referee testing for the compaction of that particular lot.

(3) Referee Testing Performed for Both Mixture Properties and Compaction:

When referee testing is performed, as described above, for both the mixture properties lot and the compaction lot, the Engineer will use the referee test results to determine new PT's as specified in Subsections 416-9(J)(1) and 416-9(J)(2).

The Department will pay for the referee testing; however, if the combined pay factor of the lot (Mixture Properties plus Compaction) does not improve or is reduced, or if either the mixture properties lot or compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties and compaction of that particular lot.

USE WHEN SPECIFIED IN THE MATERIALS DESIGN REPORT

USE STORED SPECIFICATION 109PAVSM WHEN AN
INCENTIVE/DISINCENTIVE PAYMENT FOR ASPHALTIC CONCRETE
PAVEMENT SMOOTHNESS IS SPECIFIED IN
THE MATERIALS DESIGN REPORT

USE IN CONJUNCTION WITH THE FOLLOWING:

BID ITEM: 9240170

STORED SPECIFICATIONS: 924CQC

1001MATL

FILL IN THE FOLLOWING:

416-2 EFFECTIVE VOIDS (As Needed)

RATIO MINIMUM VALUE (1 place)

416-3 UNIT WEIGHTS (As Needed)

PERCENTAGES (As Needed)

416-3.03(B) TYPE OF ASPHALT BINDER (1 place)

(416ROLL, ~~01/26/16~~ XX/XX/16)

SECTION 416 ASPHALTIC CONCRETE – END PRODUCT: of the Standard Specifications is revised to read:

416-1 **Description:**

The work under this section shall consist of constructing Asphaltic Concrete-End Product, hereinafter asphaltic concrete, by furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture, and bituminous material (asphalt cement) to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of the specifications.

Reclaimed asphalt pavement (RAP), as defined in Subsection 416-3.04, may be used in the mixture provided all requirements of the specifications are met; however, RAP will not be allowed in the mixture when asphalt cement type PG 76-22 TR+ or PG 70-22 TR+ is specified in Subsection 416-3.03(B). References to the use of RAP in this section apply only if RAP is utilized as part of the mixture. ADOT Materials Policy and Procedure Directive No. 20, "Guidance on the Use of Reclaimed Asphalt Pavement (RAP) in Asphaltic Concrete", shall be used in conjunction with the requirements of the specifications.

The contractor shall acquire and make all arrangements for a source or sources of material, furnish a mix design which will meet the design criteria specified hereinafter, and provide all the equipment, materials, and labor necessary to complete the work.

416-2 Asphaltic Concrete Mix Design Criteria:

Mix designs shall be developed by the contractor on the basis of the following criteria and tested in accordance with the requirements of the following test methods:

Criteria	Requirements			Arizona Test Method		
	1/2” Mix	3/4” Mix	Base Mix			
1. Voids in Mineral Aggregate: %, Range	15.5 - 18.5	15.0 - 18.0	14.5 - 17.0	Note (1)		
2. Effective Voids: %, Range	<u>X.X</u> ± 0.2	<u>X.X</u> ± 0.2	<u>X.X</u> ± 0.2	Note (1)		
3. Absorbed Asphalt: %, Range	0 - 1.0	0 - 1.0	0 - 1.0	Note (1)		
4. Index of Retained Strength: %, Note (2)	60	60	60	Note (3)		
5. Wet Strength: psi, Minimum	150	150	150	Note (3)		
6. Stability: pounds, Minimum	2,000	2,000	3,000	Note (1)		
7. Flow: 0.01-inch, Range	8 - 16	8 - 16	8 - 16	Note (1)		
8. Mix Design Grading Limits:				201		
Sieve Size	Percent Passing					
	1/2 inch Mix		3/4 inch Mix		Base Mix	
	Without Admix.	With Admix.	Without Admix.	With Admix.	Without Admix.	With Admix.
1-1/4 in.					100	100
1 inch			100	100	90 -100	90 – 100
3/4 inch	100	100	90 – 100	90 – 100	85 – 95	85 – 95
1/2 inch	90 – 100	90 – 100	---	---	---	---
3/8 inch	67 – 82	67 – 82	62 – 77	62 – 77	57 – 72	57 – 72
No. 8	40 – 48	41 – 49	37 – 46	38 – 47	32 – 42	33 – 43
No. 40	10 – 18	11 – 19	10 – 18	11 – 19	8 – 16	9 – 17
No. 200	1.5 – 4.5	2.5 – 6.0	1.5 – 4.5	2.5 – 6.0	1.5 – 3.5	2.5 – 5.0
(1) For mixes without RAP, Arizona Test Method 815. For mixes with RAP, Arizona Test Method 833.						
(2) If the average elevation of the project is above 3500 feet, the index of retained strength shall be a minimum of 70 percent.						
(3) For mixes without RAP, Arizona Test Method 802 (as modified by Arizona Test Method 815). For mixes with RAP, Arizona Test Method 802 (as modified by Arizona Test Method 833).						

- (4) The ratio of the mix design composite gradation target for the No. 200 sieve, including mineral admixture, to the effective asphalt content shall be within the range specified below:

$$\frac{\text{Mix Design Composite Gradation Target}}{\text{Effective Asphalt Content}} = \underline{\text{X.X}} \text{ to } 1.2$$

416-3 Materials:

For comparative purposes, quantities shown in the bidding schedule have been calculated based on the following data:

(In the following table, use only the columns called for in the Materials Design Report.)

Standard Mixes	1/2" Mix	3/4" Mix	Base Mix
Unit Weight (lb./cu. ft.)	<u>XXX</u>	<u>XXX</u>	<u>XXX</u>
Asphalt Cement, %	<u>X.X</u>	<u>X.X</u>	<u>X.X</u>
Mineral Admixture, %	1.0	1.0	1.0

416-3.01 Mineral Aggregate:

(A) General:

Mineral aggregate shall consist of virgin aggregate, or a combination of virgin aggregate and aggregate from RAP (RAP aggregate). When the terms "mineral aggregate" or "aggregate" are used without being further described as "virgin" or "RAP", the intended meaning is the total aggregate material used in the mixture.

No individual stockpile or hot bin usage of either virgin aggregate or RAP aggregate shall be less than three percent of the total mineral aggregate.

(B) Virgin Mineral Aggregate:

The contractor shall provide a source in accordance with the requirements of Section 1001, except that sub-paragraph (3) under Subsection 1001-3.01(B) shall not apply.

Coarse virgin mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine virgin mineral aggregate shall consist of natural sand or of sand prepared from rock, or other approved inert materials, or a combination thereof, conforming to the requirements of these specifications.

(C) RAP Mineral Aggregate:

RAP aggregate shall consist of the aggregate portion of the reclaimed asphalt pavement. A maximum of 25 percent RAP aggregate, by weight of total aggregate in the mix, may be used in mixes placed in a lower lift (minimum 2" below finished surface). A maximum of 20 percent RAP aggregate, by weight of total aggregate in the mix, may be used at all other locations.

(D) Mineral Aggregate Characteristics:

Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent the thorough coating with the asphalt cement.

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Oven Dry Specific Gravity (1)	Arizona Test Method 251	2.350 - 2.850
Combined Water Absorption (1)	Arizona Test Method 251	0 - 2.5%
Sand Equivalent (1)	AASHTO T 176 (After thoroughly sieving the sample, no additional cleaning of the fines from the plus No. 4 material is required.)	Minimum 55
Abrasion (2)	AASHTO T 96	100 Rev., Max. 9% 500 Rev., Max. 40%
Fractured Coarse Aggregate Particles (3)	Arizona Test Method 212	Minimum 70% (at least one fractured face, determined on plus No. 4 material)
Carbonates (3) and (4)	Arizona Test Method 238	Maximum 20%
Notes: (1) When the mix design contains RAP, the requirements shall be for the virgin aggregate portion only. (2) Abrasion shall be performed separately on materials from each source of mineral aggregate, including RAP aggregate. All sources shall meet the requirements for abrasion. (3) When the mix design contains RAP, the requirements shall be for the composite of virgin and RAP aggregate.		

- (4) Testing for carbonates only applies if either of the following conditions exist:
- (a) The asphaltic concrete is the designed final pavement surface normally used by traffic.
 - (b) The asphaltic concrete, temporary or otherwise, will be subject to traffic for more than 60 days.

Tests on aggregates outlined above, except for abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. When RAP is used in the mixture, RAP aggregates for testing shall be obtained from the RAP material using Method A of AASHTO T 164, prior to combining with the virgin aggregate.

Virgin mineral aggregate from a source or combination of sources which does not meet the requirements given in the table above for combined bulk oven dry specific gravity, and/or combined water absorption (up to a maximum of 3.0 percent), but meets the other specified requirements, will be considered for acceptance by the Engineer if: a) the total estimated cost of all asphaltic concrete components, using the mix design unit weight, asphalt cement content, and mineral admixture percentage, does not exceed the total amount bid for these items by more than 5.0 percent; or b) a supplemental agreement is executed adjusting the unit prices of asphaltic concrete components such that the total estimated cost does not exceed the total amount bid by more than 5.0 percent.

416-3.02 Mineral Admixture:

Mineral admixture will be required. The amount used shall be 1.0 percent, by weight of the mineral aggregate, unless testing demonstrates that additional admixture is required in order to meet the mix design criteria for Wet Strength and Index of Retained Strength. A maximum of 2.0 percent admixture will be permitted. The exact amount of admixture required shall be specified in the mix design. Mineral admixture shall be either Portland cement, blended hydraulic cement or hydrated lime conforming to the following requirements.

Material	Requirement
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

The certification and acceptance of Portland cement, blended hydraulic cement (Type IP), and hydrated lime shall be in accordance with ADOT Materials Policy and Procedure Directive No. 13, "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, Silica Fume, and Lime".

416-3.03 Bituminous Material:

(A) General:

Bituminous material shall consist of performance grade (PG) asphalt binder (virgin binder), or a combination of virgin binder and binder from RAP (RAP binder). When the terms "bituminous material", "asphalt cement", "asphalt binder" or "binder" are used without being further described as "virgin" or "RAP", the intended meaning is the total bituminous material used in the mixture.

The percent of asphalt cement used shall be based on the weight of total mix (asphalt cement, mineral aggregate, and mineral admixture).

(B) Virgin Bituminous Material:

Virgin asphalt cement shall be a performance grade (PG) asphalt binder, conforming to the requirements of Section 1005. The type of virgin asphalt binder shall be PG **XXXXX** or, if RAP is used in the mixture, the virgin asphalt binder shall be as required to meet the blending requirements in Subsection 416-3.03(C) and Arizona Test Method 833.

The contractor shall provide the laboratory mixing and compaction temperature ranges to the mix design laboratory for each PG asphalt binder used for mix design purposes. The laboratory mixing temperature range is defined as the range of temperatures where the un-aged virgin asphalt binder has a rotational viscosity of 0.17 ± 0.02 Pascal-seconds, measured in accordance with AASHTO T 316. The laboratory compaction temperature range is defined as the range of temperatures where the un-aged virgin asphalt binder has a rotational viscosity of 0.28 ± 0.03 Pascal-seconds, measured in accordance with AASHTO T 316. The testing required in AASHTO T 316 shall be performed at 275 °F and 350 °F, and a viscosity-temperature curve developed in accordance with ASTM D 2493. The viscosity-temperature curve shall be included in the mix design report. For PG asphalt binders that have a maximum laboratory mixing temperature exceeding 325 °F or a maximum laboratory compaction temperature exceeding 300 °F, the laboratory mixing and compaction temperature ranges shall be specified in writing by the virgin asphalt binder supplier. A viscosity-temperature curve will meet this requirement for written documentation if the viscosity-temperature curve is developed and submitted by the binder supplier and includes language that the recommended laboratory mixing and compaction temperatures are within acceptable ranges, and the submittal includes a statement indicating the maximum laboratory mixing temperature to which the binder can be heated without damage. The laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used, shall be reported on the mix design. The contractor shall ensure that the asphalt binder supplier information required in this paragraph is provided to all appropriate parties in a timely manner, and that copies are included in the mix design report. The laboratory mixing and compaction temperatures are for mix design purposes only. Field mixing and compaction temperatures are specified in Subsections 416-6 and 416-7.

(C) RAP Bituminous Material:

RAP binder shall consist of the asphalt binder portion of the reclaimed asphaltic pavement. A maximum of 25 percent RAP binder, by weight of total binder in the mix, may be used in mixes placed in a lower lift (minimum 2" below finished surface). A maximum of

20 percent RAP binder, by weight of total binder in the mix, may be used at all other locations.

When less than or equal to 15 percent RAP binder is used, by weight of total binder in the mix, no testing is required on the RAP binder. When greater than 15 percent RAP binder is used, by weight of total binder in the mix, the RAP binder shall be extracted, recovered, and tested in accordance with the requirements of Arizona Test Method 833. The virgin binder grade shall be modified if necessary to ensure the blend of virgin and RAP binder meets the PG grade specified in the Subsection 416-3.03(B). However, a change of only one virgin PG binder grade (6 °C on either or both the high and low temperatures) will be allowed from that shown in Subsection 416-3.03 (B).

416-3.04 Reclaimed Asphalt Pavement (RAP):

RAP shall consist of salvaged, milled, pulverized, broken, or crushed asphalt pavement. If RAP is generated by milling, the minimum removal depth shall be 1-1/2 inches. The source of RAP may be from ADOT or other projects. The contractor shall be responsible for determining the suitability of the RAP for use in the mixture, regardless of its source.

For asphaltic concrete containing less than or equal to 15 percent RAP aggregate, all RAP material shall pass the 1-1/4" sieve. For asphaltic concrete containing greater than 15 percent RAP aggregate, the RAP material shall be processed into uniform coarse and fine stockpiles such that there will be a minimum amount of fines. The use of more than two RAP stockpiles is prohibited. The gradation, when tested in accordance with Arizona Test Method 240, shall meet the following requirements:

Stockpile	Sieve Size	Percent Passing
Coarse	1-1/4 inch	100
	3/8 inch	0-25
Fine	3/4 inch	100
	3/8 inch	75-100

The contractor may propose gradation bands differing from those shown in the table above. The proposal shall be submitted to the Engineer prior to the start of RAP processing. If approved, the required gradation bands will be adjusted accordingly.

RAP shall be stockpiled so that segregation is minimized. When two RAP stockpiles are used, acceptable methods to prevent intermingling of stockpiles shall be provided.

The Engineer reserves the right to reject obviously defective salvaged material or salvaged material that is not representative of the material used in the mix design.

416-4 Mix Design:

Utilizing mineral aggregate and RAP which has been crushed, processed, separated and stockpiled, a mix design shall be formulated and submitted by the contractor to the

Engineer. The mineral aggregate and RAP samples used for mix design purposes shall be representative of materials to be used during production.

The mix design shall be based on the mix design criteria and other requirements hereinbefore specified, utilizing asphalt cement and mineral admixture of the type and from the sources proposed for use in the production of asphaltic concrete.

The mix design shall be prepared by or under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. The mix design engineer shall meet the requirements given in ADOT Materials Policy and Procedure Directive No. 4, "Asphaltic Concrete Mix Design Proposals and Submittals". The mix design shall be provided in a format that clearly indicates all the mix design requirements and shall be sealed, signed, and dated by the mix design engineer.

The mix design shall be prepared by a mix design laboratory that has met the requirements of ADOT Materials Policy and Procedure Directive No. 19, "ADOT System for the Evaluation of Testing Laboratories".

The contractor may propose the use of a mix design that has been developed for a previous project. The proposed mix design shall meet the requirements of these specifications. The contractor shall provide evidence that the type and source of bituminous material, the type of mineral admixture, and the source and methods of producing virgin mineral aggregate and RAP have not changed since the formulation of the previous mix design. The contractor shall also provide current test results for all specified characteristics of the mineral aggregate and RAP proposed for use. The Engineer will determine if the previously used mix design is suitable for the intended use and if the previous use of the mix design was satisfactory to the Department. The Engineer will either approve or disapprove the proposed mix design. Should the Engineer disapprove the use of the previously used mix design, the contractor shall prepare and submit a new mix design proposal in accordance with the requirements of these specifications.

A previously used mix design older than two years from the date it was formulated, sealed, signed, and dated shall not be allowed for use. Once approved for use on a project, a mix design may be used for the duration of that project.

The mix design shall contain as a minimum:

- (1) The name and address of the testing organization and the person responsible for the mix design testing.
- (2) The specific location(s) of the source(s) of mineral aggregate.
- (3) The supplier, refinery, type of asphalt cement and any modifiers including polymers. The source and type of mineral admixture. The percentage of asphalt cement and mineral admixture to be used.
- (4) The anticipated mineral aggregate gradation in each stockpile.

- (5) Mix design gradation. The mix design shall contain the mineral aggregate gradation, and also the gradation with mineral admixture.
- (6) The results of all testing, determinations, etc., such as: specific gravity of each component, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, percent carbonates (if required), immersion compression results (Index of Retained Strength, wet and dry strengths), Marshall stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density.
- (7) Viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used.

When RAP is used in the mixture, the following additional information shall be included in the mix design:

- (1) The specific location(s) of the source(s) of RAP.
- (2) The anticipated RAP gradation, RAP aggregate gradation, and RAP binder content in each stockpile.
- (3) If greater than 15 percent RAP binder is used in the mixture, the results of all tests on the recovered RAP binder, as well as all tests on the blend of virgin binder and recovered RAP binder.
- (4) The percent RAP binder, virgin binder, and total binder in the mixture.
- (5) The composite gradation of virgin and RAP aggregates, with and without mineral admixture. The composite gradation of the virgin aggregate and RAP, with and without mineral admixture.
- (6) The results of all testing, determinations, etc., for the RAP, virgin aggregate, RAP aggregate, and composite of virgin and RAP aggregates as required, such as: specific gravity, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, and percent carbonates.
- (7) The viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges for the blended binder, if greater than 15 percent RAP binder is used in the mixture, as well as the actual laboratory mixing and compaction temperatures used.

Test results used in the formulation of the mix design shall be from testing performed no earlier than 45 days prior to the date the mix design is signed by the mix design engineer. Historical abrasion values may be supplied on sources provided the testing was conducted within the past two years.

The mix design shall be submitted to the Engineer under a cover letter signed by an authorized representative of the contractor.

A copy of the mix design and representative samples of the materials used in the mix design shall be submitted to the Engineer for calibration of the ignition furnace, and for the determination of sand equivalent and fractured coarse aggregate particles. Approximately 300 pounds of virgin mineral aggregate (proportional to the mix design gradation), three gallons of asphalt cement, and one gallon of mineral admixture shall be submitted. When RAP is used, a minimum of 40 pounds of representative RAP material and a minimum of 10 pounds of solvent-extracted RAP aggregate, per AASHTO T 164, Method A, shall be submitted. If RAP is fractionated, the RAP and RAP aggregate from each stockpile shall be kept separate. The Engineer shall witness the sampling of the virgin mineral aggregate and RAP. The mix design and samples shall be submitted to the Engineer at least five working days prior to the start of asphaltic concrete production.

The sand equivalent and fractured coarse aggregate particles shall meet the requirements specified in Subsection 416-3.01.

If the mineral aggregate fails to meet the requirements specified herein, asphaltic concrete production shall not commence, and the contractor shall either submit a revised mix design which is representative of the materials produced or correct the deficiencies in the aggregate stockpiles.

The Engineer will review the mix design to assure that it contains all required information. If it does not, it will be returned within two working days of receipt of all samples and mix design information, for further action and resubmission by the contractor.

If the contractor elects to change its source(s) of mineral aggregate or RAP, or adds or deletes the use of a stockpile(s) regardless of source, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

If changes are made in the source or type of bituminous material, or the type of mineral admixture, the contractor shall provide verification testing results. Verification testing shall be performed at the original mix design asphalt content using the original mineral aggregate and RAP (if used), the proposed bituminous material, and/or the proposed mineral admixture. Three specimens shall be fabricated and tested for bulk density, maximum theoretical density, and effective voids. The percent effective voids must be within ± 0.2 of the percent effective voids in the original design and also be within the current effective voids mix design specification limits. Verification testing results shall not replace target values shown in the original mix design. All target values from the original design shall be used in future production with the exception of any self-directed target value changes that are requested. The verification process does not ensure that the contractor can meet the target values during production.

In addition to the verification testing specified above, verification testing for immersion compression may also be required. If there is a change in the type of mineral admixture, immersion compression testing is required. If there is a change in the source or type of bituminous material, immersion compression testing is required if the Index of Retained

Strength of the original mix design is less than ten percentage points greater than the specified minimum, or if the Wet Strength is less than 100 psi greater than the specified minimum.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing and acknowledged by the Engineer prior to start of production for a lot. Self-directed target changes shall meet contract requirements for mix design criteria and grading limits.

MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (sieve size):	
3/8 inch	±4% from mix design target value
No. 8	±4% from mix design target value
No. 40	±2% from mix design target value
No. 200	±0.5% from mix design target value
Asphalt Cement Content	±0.2% from mix design target value
Effective Voids	None

The contractor may propose target changes to the approved mix design for the Engineer's approval. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and grading limits. For acceptance purposes, target changes will not be retroactive.

In no case shall the approval of mix design changes relieve the contractor of the responsibility for the results obtained by the use of such approved changes.

Should a mix design prove unsatisfactory to the contractor during production, the contractor shall furnish the Engineer with a revised mix design. For acceptance purposes, the revised mix design will not be retroactive.

The contractor shall not change its methods of crushing, screening, washing, or stockpiling from those used during production of material used for mix design purposes without approval of the Engineer or without preparing a new mix design.

416-5 Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C). At the weekly meeting, the contractor shall be prepared to explain and discuss how the following processes will be employed.

- (a) Aggregate production, including crusher methods, pit extraction, and washing.
- (b) RAP production, including milling, crushing, screening, and handling methods.
- (c) Stockpile management, including stacking methods, separation technique, plant feed technique, stockpile pad thickness, and segregation prevention.

- (d) Proportioning and plant control, including plant scale calibration, mix temperature control, storing method, and addition of admixture.
- (e) Transporting and placing, including hauling distance and temperature control, segregation and non-uniform placement control, and joint placement and technique.
- (f) Compaction, including types and weight of rollers, establishing and monitoring of roller patterns, and temperature controls.

The contractor shall obtain samples and perform the tests specified in the following table:

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	TEST METHOD	SAMPLING POINT	MINIMUM TESTING FREQUENCY
Virgin Mineral Aggregate			
Gradation	ARIZ 201	Crusher Belt or Stockpile	1 per stockpile per day
Sand Equivalent	AASHTO T 176		1 per 2000 Tons of total virgin aggregate (1)
Fractured Coarse Aggregate Particles	ARIZ 212		
Reclaimed Asphalt Pavement			
Gradation, Moisture Content, and Binder Content	ARIZ 428 (Appendix A)	Crusher Belt or Stockpile	1 per stockpile per day
RAP Aggregate			
Gradation	ARIZ 201	Crusher Belt or Stockpile	1 per stockpile per day
Fractured Coarse Aggregate Particles	ARIZ 212		1 per stockpile every other day
Asphaltic Concrete			
Gradation	ARIZ 201 or 427 (428 for RAP mixes)	Cold Feed, Hot Bins, Roadway, or Plant	1 per 1000 Tons
Asphalt Content	ARIZ 421, 427 (428 for RAP mixes),or other approved methods	Roadway or Plant	1 per 1000 Tons

Voids	ARIZ 410, 415, 417, 424		1 per 1000 Tons each day. Maximum of 4 per day.
Compaction	ARIZ 412	Roadway	1 per 300 tons
Notes:			
(1) Prior to the completion of the mix design, quality control tests on mineral aggregate shall be performed based on the anticipated percent use of each stockpile. Samples taken from individual stockpiles may be composited prior to performing the required tests, or testing may be performed on material from each stockpile and the composite test result for each required test determined mathematically.			

416-6 Construction Requirements:

The contractor shall be responsible for the proportioning of all materials, for the hauling, placing, loading, spreading, and finishing of asphaltic concrete and for the applying of bituminous material, such as tack coats, prime coats, and provisional seals, all in accordance with the appropriate portions of the specifications.

The asphaltic concrete hot plant shall conform to the requirements of Section 403 of the Specifications.

During production, the percent RAP aggregate and percent RAP binder shall not exceed the maximum allowed in Subsections 416-3.01(C), 416-3.03(C), and 416-3.04. In addition, the percent RAP material shall be maintained to within plus 2 percent and minus 5 percent of the mix design value(s). When two RAP stockpiles are used, this tolerance shall apply to the total percent RAP material in the mixture, as well as the percent RAP material from each stockpile.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the drier shall not exceed 325 °F unless a higher temperature is recommended in writing by the asphalt binder supplier and approved by the Engineer.

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

Self-propelled paving machines shall spread the mixture within the specified tolerances, without segregation or tearing, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which shall distribute the mixture uniformly in front of adjustable screeds.

Pavers shall be equipped with a screed for the full width being paved, heated if necessary, and capable of spreading and finishing all courses of asphaltic concrete.

Pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope.

Failure of the control system to function properly shall be cause for the suspension of the placing of asphaltic concrete.

The base or subgrade upon which asphaltic concrete is to be placed shall be prepared and maintained in a firm condition until asphaltic concrete is placed. It shall not be frozen or excessively wet.

At any time, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors and other equipment surfaces shall be treated when necessary with a release agent approved by the Engineer in order to prevent the sticking of asphaltic concrete. Release agents which degrade, dissolve, or in any way damage the bituminous material shall not be used. Diesel fuel shall not be used as a release agent.

Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of any immediate underlying course.

When surfacing courses are placed on 10 foot or wider shoulders which are to receive rumble strips, the contractor shall place any longitudinal joints approximately one foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the centerline between two adjacent lanes. Joints shall be formed by a slope shoe or hot-lapped, and shall result in an even, uniform surface.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth of the lift and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

All locations where plate samples are taken from the roadway shall be immediately repaired by the contractor utilizing hot asphaltic concrete. All holes where cores are taken shall be repaired within 48 hours after coring using a material approved by the Engineer. All holes shall be in a dry condition prior to repair. The patching material shall be thoroughly compacted in the holes by the contractor.

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked in accordance with the requirements of Section 404. The cleaning of the surface, the tacking of the surface, and the type of bituminous material used shall be acceptable to the Engineer. The amount of bituminous material used shall be as directed by the Engineer.

A light coat of bituminous material shall be applied to edges or vertical surfaces against which asphaltic concrete is to be placed.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent. The moisture content will be determined in accordance with Arizona Test Method 406.

416-7 Acceptance:

416-7.01 General:

In addition to the random acceptance samples taken from each lot, the Engineer may sample and reject material which appears to be defective. Such rejected material shall not be used in the work. The results of tests run on rejected material will not be included with the lot acceptance tests.

Acceptance will be on the basis of the following:

- Sand Equivalent
- Fractured Coarse Aggregate Particles
- Material Spread
- Gradation
- Asphalt Cement Content
- Effective Voids
- Stability
- Compaction
- Smoothness

416-7.02 Sand Equivalent and Fractured Coarse Aggregate Particles of Mineral Aggregate:

During asphaltic concrete production, the Engineer shall obtain and test samples of material for the determination of the sand equivalent and fractured coarse aggregate

particles. When RAP is used in the mixture, the sand equivalent shall be determined on the composite of virgin aggregates only. Samples shall be obtained from the cold feed belt prior to the addition of mineral admixture, or from the stockpiles when sampling from the cold feed belt is not possible.

When RAP is used in the mixture, the material for determining the fractured coarse aggregate particles shall come from an asphaltic concrete sample taken and tested in accordance with Arizona Test Method 428, as specified in Subsection 416-7.04(A). However, if the Engineer determines that excessive breakdown of the aggregate has occurred due to the use of the ignition furnace, the fractured coarse aggregate particles testing shall be performed on the combination of RAP aggregate, as obtained in accordance with Arizona Test Method 428, and virgin mineral aggregate.

Virgin mineral aggregate will be acceptable for sand equivalent if it meets the minimum requirements specified in Subsection 416-3.01.

The fractured coarse aggregate particles shall meet the minimum requirements specified in Subsection 416-3.01.

If the mineral aggregate fails to meet the requirements specified herein, operations shall cease and the contractor shall have the option of submitting a revised mix design conforming to the requirements of Subsection 416-4 or correcting deficiencies in the aggregate stockpiles.

416-7.03 Material Spread:

A spread lot shall be considered to be one-half shift of production. Lots encompassing more than one project shall be separated in accordance with Subsection 416-9(D).

The contractor shall record information pertaining to each spread lot on forms provided by the Engineer. Information shall include the project number, date and period of time that each spread lot was placed, the spread lot number, beginning and ending station, the plans thickness, and tons placed in each lot. Completed spread lot forms shall be signed by the contractor and given to the Engineer at the end of each shift.

The Engineer will calculate the quantity required in each spread lot using the mix design bulk density unless a request is made by the contractor to use a production bulk density. If a request is made to use production bulk density, the first three non-rejected lots following the test lot will be used to determine the average production bulk density. All lots placed prior to establishing the average production bulk density shall be calculated using the mix design bulk density. For each new mix design used on the project, a new production bulk density may be requested by the contractor. In addition, if conditions warrant during asphalt production, the contractor may request establishment of a new average production bulk density. A request All requests to use a production bulk density shall be made in writing and approved by the Engineer prior to use. The same procedure will be used for determining average production bulk density in all cases. Changes to the bulk density for calculating spread quantities will shall not be retroactive.

The calculated quantity required in each spread lot will be compared to the actual quantity placed. A lot will be considered to be acceptable, with a zero pay factor, if the actual quantity placed varies by no more than -2.0 to +5.0 percent from the required quantity.

If the quantity in a lot is found to vary from the required quantity by -2.1 to -12.0 percent, the appropriate pay factor will be determined in accordance with Table 416-1. This pay factor will be utilized in determining the pay adjustment as outlined in Subsection 416-9.

416-7.04 Gradation, Asphalt Cement Content, Effective Voids, and Stability:

(A) General:

A mixture properties lot shall be considered to be one shift's production. In the event a shift's production is less than 1200 tons, multiple shifts may be combined to form a lot. When a lot consists of production from more than one shift, the following conditions apply: at least one sample shall be taken each shift, at least one sample shall be taken every 500 tons, and no mix design or target value changes shall be made within the lot. If changes are made in the mix design or target values, new lots will be established.

Four samples of the asphaltic concrete shall be taken for each lot by the contractor, under the observation of the Engineer, at random locations designated by the Engineer. Samples will be taken in accordance with the requirements of Section 2 or 3 of Arizona Test Method 104 and delivered to the Engineer immediately after being taken. The minimum weight of the sample shall be 75 pounds. The Engineer will split the sample and save one-half for 15 days after written notification to the contractor of test results for that lot has been made. The material will be tested by the Engineer for the following properties:

Test Property	Test Method
Asphalt Cement Content	Arizona Test Method 427 (428 for RAP mixes) (See Notes 1 and 2 below)
Gradation	
Marshall Density and Stability	Arizona Test Method 410
Maximum Theoretical Density	Arizona Test Method 417
Effective Voids	Arizona Test Method 424
Notes: (1) A new calibration of the ignition furnace shall be performed for each mix design, and at any other time the Engineer directs. (2) Ignition furnace results will be corrected for asphalt cement content in accordance with Subsection 416-7.04(B) or (C) as required.	

Acceptance testing results will be furnished to the contractor within four working days of receipt of samples by the Engineer.

A mixture-properties lot placed with an average stability below 2,500 pounds for base mixes, or 1,750 pounds for 1/2 or 3/4 inch mixes shall be rejected, and shall be subject to an

engineering analysis of anticipated performance in accordance with Subsection 416-9(E). Production shall cease until the contractor proposes a corrective action the Engineer finds acceptable. If the Engineer rejects the proposed corrective action, the contractor shall submit a revised mix design.

The target values for gradation, asphalt cement content, and effective voids are given in the contractor's mix design. The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each of the measured characteristics are as follows:

Measured Characteristics	LL (Note 1)	UL (Note 1)
Gradation (Sieve size):		
3/8 inch (Note 2)	TV - 6.0	TV + 6.0
No. 8	TV - 6.0	TV + 6.0
No. 40	TV - 5.0	TV + 5.0
No. 200	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.50	TV + 0.50
Effective Voids	TV - 2.0	TV + 1.5
Notes:		
(1) The limits are used in the statistical calculations for Quality Index. Acceptance is controlled by the variability of the produced material and every effort should be made to strive for the applicable target value (TV).		
(2) In the case of the 3/8 inch sieve requirement, for the base mix only, the lower limit shall be the target value minus 8.0, and the upper limit shall be the target value plus 8.0.		

The Engineer will determine the PT for each measured characteristic in accordance with Subsection 416-9(I), and utilizing Table 416-1 will determine the pay factor for each measured characteristic.

In the event the contractor elects to question the mixture property test results, the contractor may request referee testing in accordance with Subsection 416-9(J).

(B) Ignition Furnace Correction for Non-RAP Mixes:

For plants providing asphaltic concrete exclusively for the project, the difference between the asphalt cement content as measured by ignition furnace testing and the actual asphalt cement content shall be determined by the Engineer for each of the first five lots of asphaltic concrete produced for each mix design. If there are less than five lots for the mix design, the total number of available lots shall be used. If approved by the Engineer, a plant may be considered exclusive to the project if an asphalt cement tank is dedicated for the shift of asphaltic concrete production. The determination of the actual asphalt cement content may include weighing of asphalt cement deliveries, invoice quantities, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted materials. If a computerized mass-flow meter is used, documentation of its calibration shall be submitted to the Engineer

prior to asphaltic concrete production. At any time during asphaltic concrete production, the Engineer may require that a new calibration of the mass-flow meter be performed. If the average difference exceeds ± 0.10 percent asphalt cement content between the asphalt cement content measured by ignition furnace testing and the actual asphalt cement content, the contractor may request that a correction to the asphalt cement content by ignition furnace testing be made. The contractor must make such a request in writing within two working days after receiving the test results for the fifth lot of asphaltic concrete production. If referee testing is performed on a lot of asphaltic concrete for which a correction, based on the actual asphalt cement content, was made to the asphalt cement content by ignition furnace testing, referee testing shall not apply to the determination of asphalt cement content. The correction, once documented and approved by the Engineer, shall be applied to test results from the beginning of asphaltic concrete production through the remainder of asphaltic concrete production using that mix design; however, a new correction may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances. If the contractor submits a new mix design, a new correction must be established and applied as specified above. For plants not providing asphaltic concrete exclusively for this project, no correction will be made to asphalt cement content values measured by ignition furnace testing.

(C) Ignition Furnace Correction for Mixes Containing RAP:

For mixes containing RAP, an asphalt cement tank shall be dedicated to the project for each shift of asphaltic concrete production. The difference between the asphalt cement content as measured by ignition furnace testing and the actual asphalt cement content shall be determined by the Engineer for each of the first five lots of asphaltic concrete produced for each mix design. If there are less than five lots for the mix design, the total number of available lots shall be used. The actual asphalt cement content shall be determined by adding the virgin asphalt cement content to the RAP binder content determined in Subsection 416-7.04(D), both expressed as a percent of the total mix. The determination of the virgin asphalt cement content may include weighing of asphalt cement deliveries, invoice quantities, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted materials. If a computerized mass-flow meter is used, documentation of its calibration shall be submitted to the Engineer prior to asphaltic concrete production. At any time during asphaltic concrete production, the Engineer may require that a new calibration of the mass-flow meter be performed. If the average difference exceeds ± 0.10 percent asphalt cement content between the asphalt cement content measured by ignition furnace testing and the actual asphalt cement content, a correction to the asphalt cement content by ignition furnace testing shall be made. The correction shall be applied to test results from the beginning of asphaltic concrete production through the remainder of asphaltic concrete production using that mix design; however, a new correction may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances. If the contractor submits a new mix design, a new correction must be established and applied as specified above. Referee testing shall not apply to the determination of asphalt cement content for asphaltic concrete containing RAP.

(D) RAP Binder Content:

(1) General:

During asphaltic concrete production, the Engineer shall obtain and test samples of the RAP material to determine the RAP binder content in each stockpile at a minimum frequency of one sample per lot. The RAP will be tested by the Engineer for asphalt binder content in accordance with Arizona Test Method 428. When more than one RAP sample is tested for a given lot and stockpile, the average of the results shall be used.

(2) RAP Binder Content Correction Factor:

A RAP binder correction factor shall be determined for each RAP stockpile used in the mixture.

At the start of asphaltic concrete production, the first two samples of RAP material from each stockpile will be split and tested for asphalt binder content; one split is tested in accordance with Arizona Test Method 428 (ignition furnace) and the other split is tested in accordance with AASHTO T 164 (solvent extraction). A RAP binder correction factor will be determined by subtracting the average ignition furnace result from the average solvent extraction result. The appropriate correction factor shall be added to each asphalt binder test result determined on the material from each RAP stockpile in accordance with Arizona Test Method 428 to determine the RAP binder content. At the discretion of the Engineer, the correction factor may be determined prior to the start of asphaltic concrete production provided representative RAP samples are available. A new correction factor may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances.

416-7.05 Compaction:

(A) All Courses Regardless of Thickness:

(1) General Requirements:

Asphaltic concrete shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 degrees F and the ambient temperature at the beginning of placement is at least 65 degrees F and rising. The placement shall be stopped when the ambient temperature is 70 degrees F or less and falling.

Asphaltic concrete immediately behind the laydown machine shall be a minimum of 275 degrees F.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

(2) Equipment:

Compacting and smoothing shall be accomplished by the use of self-propelled equipment. Compactors shall be pneumatic-tired and/or steel wheel.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Steel wheel compactors shall weigh not less than eight tons.

Pneumatic-tired compactors shall be the oscillating type with at least seven pneumatic tires of equal size and diameter. Wobble-wheel compactors will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be capable of being inflated to 90 pounds per square inch and maintained so that the air pressure will not vary more than five pounds per square inch from the designated pressure. Pneumatic-tired compactors shall be constructed so that the total weight of the compactor will be varied to produce an operating weight per tire of not less than 5,000 pounds. Pneumatic-tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

(3) Rolling Method Procedure:

Compaction shall consist of an established sequence of coverage using specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used, and the number of coverages required shall be as follows:

Rolling Sequence	Type of Compactor		No. of Coverages	
	Option No. 1	Option No. 2	Option No.1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2- 4*
Finish	Static Steel	Static Steel	1-3	1-3
* Based on the roller pattern which exhibits the best performance.				

The Engineer shall select the option for compaction and, when pneumatic-tired compactors are used, will designate the tire pressure.

One pneumatic-tired roller shall be furnished for each 300 tons of asphaltic concrete per hour.

Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F.

Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 degrees F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified, and with the number of coverages of the compactors as specified.

(B) Blank:

416-7.06 Smoothness and Surface Tolerances:

Asphaltic concrete shall be compacted as required, smooth and true to the required lines, grades, and dimensions.

The Special Provisions may require the smoothness of the final pavement surface to be tested in accordance with Subsection 109.13.

Regardless of whether testing in accordance with Subsection 109.13 is specified or not, the following requirements shall be met:

- (1) The surface of the final lift of asphaltic concrete placed under this section of the specifications shall be tested and shall not vary by more than 1/8 inch from the lower edge of a ten-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints.
- (2) The surface of any lift of asphaltic concrete placed under this section of the specifications, other than the final lift, shall be tested and shall not vary by more than 1/4 inch from the lower edge of a ten-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints.
- (3) All deviations exceeding the specified tolerances above shall be corrected by the contractor, to the satisfaction of the Engineer.

416-8 Method of Measurement:

(A) Asphaltic Concrete:

Asphaltic concrete will be measured by the ton for the asphaltic concrete actually used, which will include the weight of mineral aggregate, asphalt cement, and mineral admixture. Measurement will include any quantity used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

(B) Asphalt Cement:

(1) Non-RAP Mixes:

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsections 416-7.04(A) and (B) for each lot of asphaltic concrete accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. If the contractor has requested referee testing, the average asphalt cement content will come from the independent testing laboratory results unless a correction, based on the actual asphalt cement content, was made to the ignition furnace test value as allowed in Subsection 416-7.04(B). If a correction, based on the actual asphalt cement content, was made to the ignition furnace test value, the average asphalt cement content determined from the Department's acceptance testing will be used. At the discretion of the Engineer, asphalt cement may be measured by invoice quantities, adjusted as necessary for waste. Waste generated from startup of the asphalt plant will be considered to have a binder content of 3.0 percent. In no case shall the measured amount of asphalt cement for payment be greater than the total of the invoice quantities, adjusted for waste.

(2) Mixes Containing RAP:

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsections 416-7.04(A) and (C) for each lot of asphaltic concrete accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. At the discretion of the Engineer, asphalt cement may be measured by adding invoice quantities to the RAP binder used, adjusted as necessary for waste. RAP binder used shall be determined by multiplying the RAP binder content determined in Subsection 416-7.04(D) by the number of tons of dry RAP material used in that lot. Waste generated from startup of the asphalt plant will be considered to have a binder content of 3.0 percent. In no case shall the measured amount of asphalt cement for payment be greater than the total of the invoice quantities plus the RAP binder as determined above, adjusted for waste.

(C) Mineral Admixture:

Mineral admixture will be measured by the ton for the mineral admixture actually used in accordance with Subsection 403-2.

416-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price adjusted by the appropriate pay factors as hereinafter provided.

For the purpose of determining acceptability and appropriate pay factors, each unit of asphaltic concrete will be included in two separate lots: a "spread lot" and a "mixture properties lot." The total unit price for any unit of accepted asphaltic concrete will be the contract unit price, adjusted by the applicable spread lot pay factor and mixture properties lot pay factor.

The contractor may request to place the first lot of each mix type as a test strip. Requests to place a test strip shall be made in writing and acknowledged by the Engineer prior to start of production. A test strip shall be limited to 1,000 tons and may only be placed on

shoulders, ramps, cross roads, or other areas approved by the Engineer. A test strip shall be excluded from the mixture properties lot pay factor; however, all other provisions of Subsection 416-9 shall still apply to such areas.

The Engineer may exclude asphaltic concrete from the spread lot and from the spread lot pay factor calculations if the Engineer determines that the proposed use of the material or the existing surface conditions are not conducive to the use of spread lots.

The Engineer may exclude certain locations from the mixture properties lot and from the random sampling used in determining the mixture properties lot pay factor should the Engineer determine that the location of the work precludes normal construction operations.

(A) Spread Lot Pay Factor:

The spread lot pay factor will be determined in accordance with Subsection 416-7.03. If the quantity in a spread lot is found to vary by more than + 5.0 percent from the required quantity, no payment will be made for the material which exceeds + 5.0 percent, including asphalt cement and mineral admixture. If the quantity is found to vary by more than - 12.0 percent from the required quantity, the spread lot will be rejected.

(B) Mixture-Properties Lot Pay Factor:

The mixture properties lot pay factor shall be determined in accordance with the following procedure:

- (1) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids shall be determined as set forth in Subsection 416-7.04.
- (2) A single pay factor shall be determined for Gradation and Asphalt Cement Content. That pay factor shall be the lowest pay factor for the individual measured characteristics for Gradation and Asphalt Cement Content.
- (3) If no individual PT value in (1) above is less than 50, the mixture properties lot pay factor shall be the sum of the pay factor determined in (2) above and the Effective Voids pay factor. The negative pay factor for mixture properties shall not exceed \$3.00 per ton. If any individual PT value is less than 50, the lot is in reject and the provisions in Subsection 416-9(E) shall apply.

(C) Blank:

(D) Determination of Lot Pay Factors on Contracts Involving Multiple Projects:

When more than one project is included in a single contract, placement during a shift or half shift of production may encompass more than one project. In such case, the applicable spread lot pay factor and mixture properties lot pay factor for each project shall be determined as follows:

- (1) Spread lot pay factors will be determined separately for each project utilizing the procedure set forth in Subsection 416-7.03.
- (2) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids will be determined from the results of the random samples taken and tested in accordance with Subsection 416-7.04, regardless of which project(s) the samples fall within.
- (3) The mixture properties lot pay factor shall be determined separately for each project in accordance with Subsection 416-9(B), utilizing the individual pay factors determined in (2) above.

(E) Acceptability:

Asphaltic concrete included in any mixture properties lot possessing an individual PT value lower than 50 for Gradation, Asphalt Cement Content, or Effective Voids will be rejected.

Within 15 days after receiving notice that a spread lot or mixture properties lot of asphaltic concrete has been rejected by the Engineer, the contractor may submit a written proposal to accept the material in place at the applicable maximum negative pay factor(s). Maximum negative pay factors are defined as a minus \$1.00 per ton for spread lots, minus \$3.00 per ton for mixture properties lots in reject for gradation only, minus \$5.00 per ton for mixture properties lots in reject for asphalt cement content and/or effective voids only, and minus \$5.00 per ton for mixture properties lots in reject for asphalt cement content and/or effective voids and also gradation. In addition, for any mixture properties lot that is in reject due to asphalt cement content but allowed to remain in place, payment shall not be made for asphalt cement quantities in excess of the upper limit (UL) as determined in Subsection 416-7.04(A).

The proposal shall contain an engineering analysis of the anticipated performance of the asphaltic concrete if left in place. The engineering analysis shall also detail any proposed corrective action, and the anticipated effect of such corrective action on the performance. The engineering analysis shall be performed by an independent professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected mixture properties lot is submitted for referee testing by the contractor, the 15 days allowed to prepare an engineering analysis will begin upon notification of referee test results.

Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is not accepted, the asphaltic concrete shall be removed at no additional cost to the Department and replaced with asphaltic concrete meeting the requirements of these specifications. If the proposal is accepted, the asphaltic concrete shall remain in place at the applicable maximum negative pay factor(s), and any necessary corrective action shall be performed at no additional cost to the Department.

The Department reserves the right to suspend the work should any of the following conditions occur:

- (1) The occurrence of two or more rejected lots within any ten consecutive production lots.
- (2) The occurrence of three consecutive negative mixture properties lot pay factors.
- (3) The occurrence of five or more pay factors that are negative for a mixture properties lot within any ten consecutive production lots.

If the Department elects to suspend the work for any of these conditions, the contractor shall either submit a revised mix design in accordance with Subsection 416-4, or submit for the Engineer's approval a written engineering analysis. The engineering analysis shall detail the course of action necessary to correct deficiencies in the contractor's present production methods such that further production can be accomplished without excessive amounts of asphaltic concrete in penalty or rejection. If approved by the Engineer, the revised mix design, or the course of action proposed in the engineering analysis, shall be implemented, and the work may continue. Costs or delays due to the provisions of this subsection are not compensable.

(F) Asphalt Cement:

(1) Non-RAP Mixes:

Payment for asphalt cement will be made by the ton. Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01.

(2) Mixes Containing RAP:

When RAP is used in the mixture, payment for asphalt cement will be made by the ton for the total asphalt cement as determined in Subsection 416-8(B)(2). Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01 for the virgin binder only.

(G) Mineral Admixture:

Mineral admixture will be paid for at the predetermined price established in the Bidding Schedule.

(H) Smoothness:

When required in the Special Provisions, payment for smoothness shall be made in accordance with the requirements of Subsection 109.13.

(I) Statistical Acceptance:

The "Total Percentage of Lot Within UL and LL (PT)" shall be determined in accordance with Subsection 109.11 of the Specifications.

Pay Factors (PF) shall be determined by entering Table 416-1 with PT.

TABLE 416-1 PAY FACTORS				
Material Spread		Mixture Properties		
Negative Variance (%)	Pay Factor (Dollars per Ton)	PT	Pay Factors (Dollars per Ton)	
			Gradation & Asphalt Cement Content	Effective Voids
2.1 - 3.0	- 0.10	100	0.00	+ 2.00
3.1 - 4.0	- 0.20	95 - 99	0.00	+ 0.50
4.1 - 5.0	- 0.30	90 - 94	0.00	0.00
5.1 - 6.0	- 0.40	85 - 89	0.00	- 0.25
6.1 - 7.0	- 0.50	80 - 84	- 0.25	- 0.50
7.1 - 8.0	- 0.60	75 - 79	- 0.50	- 0.75
8.1 - 9.0	- 0.70	70 - 74	- 0.75	- 1.00
9.1 - 10.0	- 0.80	65 - 69	- 1.00	- 1.25
10.1 - 11.0	- 0.90	60 - 64	- 1.50	- 1.50
11.1 - 12.0	- 1.00	55 - 59	- 2.00	- 2.00
More than 12.0	Reject	50 - 54	- 2.50	- 2.50
See Subsections 416-9 (A) and (E)		Less than 50	Reject – See Subsection 416-9 (E)	

(J) Mixture Properties Lot Referee Testing:

Within 15 days after written notification to the contractor of test results for a particular mixture properties lot, the contractor may make a written request for referee testing. The referee testing shall be performed by an independent approved laboratory designated by the Department. The testing of the samples will be performed by the independent testing laboratory without knowledge of the specific project conditions such as the identity of the contractor or mix design laboratory, the test results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for the following properties:

Test Property	Test Method
Asphalt Cement Content (See Note 1 below)	Arizona Test Method 427 (428 for RAP mixes)
Gradation	
Marshall Density and Stability	Arizona Test Method 410
Maximum Theoretical Density	Arizona Test Method 417
Effective Voids	Arizona Test Method 424

Note:

- (1) If a correction to the asphalt cement content by ignition furnace testing is made in accordance with Subsection 416-7.04(B), or if RAP is used in the mixture, the asphalt cement content shall not be subject to referee testing.

The results of the referee testing will be binding on both the contractor and the Department.

Using the referee testing results, the Engineer will determine new PT's for all characteristics, with the exception of asphalt cement content if a correction to the ignition furnace value was made as specified in Subsection 416-7.04 (B), or if RAP is used in the mixture.

The Department will pay for the referee testing; however, if the pay factor of the mixture properties lot does not improve or is reduced, or if the mixture properties lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties of that particular lot.

USE STORED SPECIFICATION 109PAVSM WHEN AN
INCENTIVE/DISINCENTIVE PAYMENT FOR ASPHALTIC CONCRETE
PAVEMENT SMOOTHNESS IS SPECIFIED IN
THE MATERIALS DESIGN REPORT

USE IN CONJUNCTION WITH THE FOLLOWING:

BID ITEM:	9240170
STORED SPECIFICATIONS:	924CQC
	1001MATL

FILL IN THE FOLLOWING:

417-1	TYPE OF MIX	(1 Place)
TABLE 417-1	EFFECTIVE VOIDS	(1 Place)
TABLE 417-1 (NOTE 3)	RATIO MINIMUM VALUE	(1 Place)
TABLE 417-1 (NOTE 4)	NUMBER OF GYRATIONS	(3 Places)
417-3	UNIT WEIGHTS	(As needed)
	PERCENTAGES	(As needed)
417-3.03(B)	TYPE OF ASPHALT BINDER	(1 place)

(417SHRP, 01/26/16 XX/XX/16)

SECTION 417 ASPHALTIC CONCRETE (END PRODUCT) SHRP VOLUMETRIC MIX:
of the Standard Specifications is revised to read:

417-1 Description:

The work under this section shall consist of constructing Asphaltic Concrete (End Product) SHRP Volumetric Mix, hereinafter asphaltic concrete, by furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture, and bituminous material (asphalt cement) to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of the specifications.

Reclaimed asphalt pavement (RAP), as defined in Subsection 417-3.04, may be used in the mixture provided all requirements of the specifications are met; however, RAP will not be allowed in the mixture when asphalt cement type PG 76-22 TR+ or PG 70-22 TR+ is specified in Subsection 417-3.03(B). References to the use of RAP in this section apply only if RAP is utilized as part of the mixture. ADOT Materials Policy and Procedure Directive No. 20, "Guidance on the Use of Reclaimed Asphalt Pavement (RAP) in Asphaltic Concrete", shall be used in conjunction with the requirements of the specifications.

Warm Mix Asphalt (WMA) technologies may be used in the mixture at the option of the contractor provided all requirements of the specifications are met. WMA is defined as asphaltic concrete that is produced within the temperature range of 215 to 275 °F. WMA can be produced by one or a combination of several WMA technologies including plant water foaming processes, mineral additives, and chemical additives. The requirements for incorporating WMA technologies in the mixture are given in these specifications and in

Materials Policy and Procedure Directive No. 23, "Requirements for the Use of Warm Mix Asphalt (WMA) Technologies in Asphaltic Concrete".

The contractor shall acquire and make all arrangements for a source or sources of material, furnish a mix design which will meet the design criteria specified hereinafter, and provide all the equipment, materials, and labor necessary to complete the work.

The type of asphaltic concrete shall be XXXXXXX mix.

417-2 Asphaltic Concrete Mix Design Criteria:

Mix designs shall be developed by the contractor. Each mix design shall meet the criteria in Table 417-1 and the grading requirements in Table 417-2 when tested in accordance with Arizona Test Method 815 for mixes without RAP and Arizona Test Method 833 for mixes with RAP, with the noted exceptions.

TABLE 417-1 ASPHALTIC CONCRETE MIX DESIGN CRITERIA		
Criteria	Requirements	
	1/2" Mix	3/4" Mix
Voids in Mineral Aggregate: %, Range	14.5-16.5	13.5-15.5
Effective Voids: %, Range	<u>X.X</u> ± 0.2	
Absorbed Asphalt: %, Range	0 - 1.0	
Index of Retained Strength: % (Arizona Test Method 802) (See Note 6 below)	60 Minimum (See Note 7 below)	
Wet Strength: psi (Arizona Test Method 802) (See Note 6 below)	150 Minimum	
Notes:		
(1) Mix design laboratory compacted test specimens, except for Arizona Test Method 802, shall be prepared using a gyratory compactor in accordance with AASHTO T 312, except compaction shall be performed to the number of gyrations specified for N-max in Note 4 below and the density of the compacted specimens shall be calculated for N-design gyrations.		
(2) The mix design shall be formulated in a manner described for Level 1 mix designs in The Superpave Mix Design Manual for New Construction and Overlays (SHRP-A-407) except that volumetrics will be determined in accordance with Arizona Test Method 815, or Arizona Test Method 833 if RAP is used, and the number of trial blend gradations necessary will be determined by the mix design laboratory. Duplicate gyratory samples shall be prepared at a minimum of 3 binder contents to select the recommended binder content. The completed mix design shall meet all the mineral aggregate and mix design criteria specified herein. In addition, when RAP is used in the mixture, SHRP-A-407 shall be modified as necessary to incorporate the RAP provisions and requirements of Arizona Test Method 833.		

- (3) The ratio of the mix design composite gradation target for the No. 200 sieve, including mineral admixture, to the effective asphalt content shall be within the range specified below:
- $$\frac{\text{Mix Design Composite Gradation Target}}{\text{Effective Asphalt Content}} = \underline{\mathbf{X.X}} \text{ to } 1.2$$
- (4) For purposes of design, the number of gyrations shall be **XXX** (N-design). The calculated density of the specimens at **XXX** gyrations (N-initial) shall be less than 89.0 percent of the maximum theoretical density. The density of the specimens at **XXX** gyrations (N-max) shall be less than 98.0 percent of the maximum theoretical density.
- (5) Oven aging period for mix design gyratory samples shall be 2 hours.
- (6) For mixes without RAP, Arizona Test Method 802 (as modified by Arizona Test Method 815). For mixes with RAP, Arizona Test Method 802 (as modified by Arizona Test Method 833).
- (7) If the average elevation of the project is above 3500 feet, the Index of Retained Strength shall be a minimum of 70 percent.

TABLE 417-2				
MIX DESIGN GRADING LIMITS FOR 3/4 INCH MIX				
Sieve Size	Coarse Band		Fine Band	
	Percent Passing			
	Without Admixture	With Admixture	Without Admixture	With Admixture
1 inch	100	100	100	100
3/4 inch	90 - 100	90 - 100	90 - 100	90 - 100
1/2 inch	43 - 89	44 - 89	60 - 89	60 - 89
No. 8	23 - 35	24 - 36	36 - 49	37 - 50
No. 40	2 - 17	3 - 18	15 - 49	16 - 50
No. 200	2.0 - 5.0	3.0 - 6.5	2.0 - 5.0	3.0 - 6.5
MIX DESIGN GRADING LIMITS FOR 1/2 INCH MIX				
Sieve Size	Coarse Band		Fine Band	
	Percent Passing			
	Without Admixture	With Admixture	Without Admixture	With Admixture
3/4 inch	100	100	100	100
1/2 inch	90 - 100	90 - 100	90 - 100	90 - 100
3/8 inch	53 - 89	53 - 89	64 - 89	64 - 89
No. 8	28 - 39	29 - 40	40 - 52	41 - 53
No. 40	2 - 19	3 - 20	17 - 52	18 - 53
No. 200	2.0 – 5.5	3.0 – 7.0	2.0 – 5.2	3.0 - 7.0
Notes:				

- (1) The contractor may provide a mix meeting the Fine Band or Coarse Band mix design grading limits unless otherwise specified.
- (2) In addition to the mineral aggregate grading requirements, the contractor's mix design shall provide a minimum of 25 percent intermediate size mineral aggregate for the 1/2" mix and 20 percent for the 3/4" mix. Intermediate size mineral aggregate is defined as the percentage of mineral aggregate passing the 3/8" sieve and retained on the No. 8 sieve in the combined mineral aggregate, exclusive of mineral admixture.

417-3 **Materials:**

For comparative purposes, quantities shown in the bidding schedule have been calculated based on the following data:

(In the following table, use only the columns called for in the Materials Design Report.)

	1/2" Mix	3/4" Mix
Unit Weight, (lb./cu. ft.)	<u>XXX</u>	<u>XXX</u>
Asphalt Cement, %	<u>X.X</u>	<u>X.X</u>
Mineral Admixture, %	1.0	1.0

417-3.01 **Mineral Aggregate:**

(A) General:

Mineral aggregate shall consist of virgin aggregate, or a combination of virgin aggregate and aggregate from RAP (RAP aggregate). When the terms "mineral aggregate" or "aggregate" are used without being further described as "virgin" or "RAP", the intended meaning is the total aggregate material used in the mixture.

No individual stockpile or hot bin usage of either virgin aggregate or RAP aggregate shall be less than three percent of the total mineral aggregate.

(B) Virgin Mineral Aggregate:

The contractor shall provide a source in accordance with the requirements of Section 1001, except that sub-paragraph (3) under Subsection 1001-3.01(B) shall not apply.

Coarse virgin mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine virgin mineral aggregate shall be obtained from crushed gravel or crushed rock. All uncrushed material passing the No. 4 sieve shall be removed prior to the crushing,

screening, and washing operations necessary to produce the specified gradation. The contractor shall notify the Engineer a minimum of 48 hours in advance of crushing the material to be used as virgin mineral aggregate, so all crushing operations can be inspected. Existing stockpile material which has not been inspected during crushing will not be permitted for use unless the contractor is able to document to the Engineer's satisfaction that the virgin mineral aggregate has been crushed. Any material inspected by the Department as crushed material shall be separated from the contractor's other stockpiles and reserved for use throughout the project duration.

For mixes which not contain RAP, the contractor may blend uncrushed fine virgin aggregate up to a maximum of 15 percent of the total aggregate for mixes meeting the fine band grading requirements or up to a maximum of 10 percent of the total aggregate for mixes meeting the coarse band grading requirements. For mixes which contain RAP, the contractor may blend uncrushed fine virgin aggregate up to a maximum of 10 percent of the total aggregate. The total composite of virgin fine aggregate shall meet the requirement for uncompacted void content. The uncrushed fine virgin aggregate shall be 100 percent passing the 1/4 inch sieve and contain not more than 4.0 percent passing the No. 200 sieve. Should the contractor modify the method of producing either the uncrushed or crushed fine aggregate, the Engineer shall be immediately notified and the materials sampled and tested for determination of uncompacted void content.

(C) RAP Mineral Aggregate:

RAP aggregate shall consist of the aggregate portion of the reclaimed asphalt pavement. A maximum of 25 percent RAP aggregate, by weight of total aggregate in the mix, may be used in mixes placed in a lower lift (minimum 2" below finished surface). A maximum of 20 percent RAP aggregate, by weight of total aggregate in the mix, may be used at all other locations.

(D) Mineral Aggregate Characteristics:

Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent the thorough coating with the asphalt cement.

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods:

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Oven Dry Specific Gravity (1)	Arizona Test Method 251	2.350 - 2.850
Combined Water Absorption (1)	Arizona Test Method 251	0 - 2.5%

Sand Equivalent (1)	AASHTO T 176 (After thoroughly sieving the sample, no additional cleaning of the fines from the plus No. 4 material is required.)	Minimum 55
Abrasion (2)	AASHTO T 96	100 Rev., Max. 9% 500 Rev., Max. 40%
Fractured Coarse Aggregate Particles (3)	Arizona Test Method 212	Minimum 85% with at least two fractured faces and minimum 92% with at least one fractured face (plus No. 4 material)
Flat and Elongated Particles (3)	ASTM D 4791 (except test shall be performed on plus No. 4 material)	Maximum 10% (of the plus No. 4 material) 5:1
Uncompacted Void Content (1)	Arizona Test Method 247	Minimum 45.0%
Carbonates (3) and (4)	Arizona Test Method 238	Maximum 20%
<p>Notes:</p> <p>(1) When the mix design contains RAP, the requirements shall be for the virgin aggregate portion only.</p> <p>(2) Abrasion shall be performed separately on materials from each source of mineral aggregate, including RAP aggregate. All sources shall meet the requirements for abrasion.</p> <p>(3) When the mix design contains RAP, the requirements shall be for the composite of virgin and RAP aggregate.</p> <p>(4) Testing for carbonates only applies if either of the following conditions exist:</p> <p>(a) The asphaltic concrete is the designed final pavement surface normally used by traffic.</p> <p>(b) The asphaltic concrete, temporary or otherwise, will be subject to traffic for more than 60 days.</p>		

Tests on aggregates outlined above, except for abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. When RAP is used in the mixture, RAP aggregates for testing shall be obtained from the RAP material using Method A of AASHTO T 164, prior to combining with the virgin aggregate.

Virgin mineral aggregate from a source or combination of sources which does not meet the requirements given in the table above for combined bulk oven dry specific gravity, and/or combined water absorption (up to a maximum of 3.0 percent), but meets the other specified requirements, will be considered for acceptance by the Engineer if: a) the total estimated cost of all asphaltic concrete components, using the mix design unit weight, asphalt cement content, and mineral admixture percentage, does not exceed the total amount bid for these items by more than 5.0 percent; or b) a supplemental agreement is executed adjusting the unit prices of asphaltic concrete components such that the total estimated cost does not exceed the total amount bid by more than 5.0 percent.

417-3.02 Mineral Admixture:

Mineral admixture will be required. The amount used shall be 1.0 percent, by weight of the mineral aggregate, unless testing demonstrates that additional admixture is required in order to meet the mix design criteria for Wet Strength and Index of Retained Strength. A maximum of 2.0 percent admixture will be permitted. The exact amount of admixture required shall be specified in the mix design. Mineral admixture shall be either Portland cement, blended hydraulic cement, or hydrated lime conforming to the following requirements:

Material	Requirement
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

The certification and acceptance of Portland cement, blended hydraulic cement (Type IP), and hydrated lime shall be in accordance with ADOT Materials Policy and Procedure Directive No. 13, "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, Silica Fume, and Lime".

417-3.03 Bituminous Material:

(A) General:

Bituminous material shall consist of performance grade (PG) asphalt binder (virgin binder), or a combination of virgin binder and binder from RAP (RAP binder). When the terms "bituminous material", "asphalt cement", "asphalt binder" or "binder" are used without being further described as "virgin" or "RAP", the intended meaning is the total bituminous material used in the mixture.

The percent of asphalt cement used shall be based on the weight of total mix (asphalt cement, mineral aggregate, and mineral admixture).

(B) Virgin Bituminous Material:

Virgin asphalt cement shall be a performance grade (PG) asphalt binder, conforming to the requirements of Section 1005. The type of virgin asphalt binder shall be PG **XXXXX** or, if

RAP is used in the mixture, the virgin asphalt binder shall be as required to meet the blending requirements in Subsection 417-3.03(C) and Arizona Test Method 833.

The contractor shall provide the laboratory mixing and compaction temperature ranges to the mix design laboratory for each PG asphalt binder used for mix design purposes. The laboratory mixing temperature range is defined as the range of temperatures where the un-aged virgin asphalt binder has a rotational viscosity of 0.17 ± 0.02 Pascal-seconds, measured in accordance with AASHTO T 316. The laboratory compaction temperature range is defined as the range of temperatures where the un-aged virgin asphalt binder has a rotational viscosity of 0.28 ± 0.03 Pascal-seconds, measured in accordance with AASHTO T 316. The testing required in AASHTO T 316 shall be performed at 275 °F and 350 °F, and a viscosity-temperature curve developed in accordance with ASTM D 2493. The viscosity-temperature curve shall be included in the mix design report. For PG asphalt binders that have a maximum laboratory mixing temperature exceeding 325 °F or a maximum laboratory compaction temperature exceeding 300 °F, the laboratory mixing and compaction temperature ranges shall be specified in writing by the virgin asphalt binder supplier. A viscosity-temperature curve will meet this requirement for written documentation if the viscosity-temperature curve is developed and submitted by the binder supplier and includes language that the recommended laboratory mixing and compaction temperatures are within acceptable ranges, and the submittal includes a statement indicating the maximum laboratory mixing temperature to which the binder can be heated without damage. The laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used, shall be reported on the mix design. The contractor shall ensure that the asphalt binder supplier information required in this paragraph is provided to all appropriate parties in a timely manner, and that copies are included in the mix design report. The laboratory mixing and compaction temperatures are for mix design purposes only. Field mixing and compaction temperatures are specified in Subsections 417-6 and 417-7.

(C) RAP Bituminous Material:

RAP binder shall consist of the asphalt binder portion of the reclaimed asphaltic pavement. A maximum of 25 percent RAP binder, by weight of total binder in the mix, may be used in mixes placed in a lower lift (minimum 2" below finished surface). A maximum of 20 percent RAP binder, by weight of total binder in the mix, may be used at all other locations.

When less than or equal to 15 percent RAP binder is used, by weight of total binder in the mix, no testing is required on the RAP binder. When greater than 15 percent RAP binder is used, by weight of total binder in the mix, the RAP binder shall be extracted, recovered, and tested in accordance with the requirements of Arizona Test Method 833. The virgin binder grade shall be modified if necessary to ensure the blend of virgin and RAP binder meets the PG grade specified in the Subsection 417-3.03(B). However, a change of only one virgin PG binder grade (6 °C on either or both the high and low temperatures) will be allowed from that shown in Subsection 417-3.03(B).

417-3.04 Reclaimed Asphalt Pavement (RAP):

RAP shall consist of salvaged, milled, pulverized, broken, or crushed asphalt pavement. If RAP is generated by milling, the minimum removal depth shall be 1-1/2 inches. The source of RAP may be from ADOT or other projects. The contractor shall be responsible for determining the suitability of the RAP for use in the mixture, regardless of its source.

For asphaltic concrete containing less than or equal to 15 percent RAP aggregate, all RAP material shall pass the 1-1/4" sieve. For asphaltic concrete containing greater than 15 percent RAP aggregate, the RAP material shall be processed into uniform coarse and fine stockpiles such that there will be a minimum amount of fines. The use of more than two RAP stockpiles is prohibited. The gradation, when tested in accordance with Arizona Test Method 240, shall meet the following requirements:

Stockpile	Sieve Size	Percent Passing
Coarse	1-1/4 inch	100
	3/8 inch	0-25
Fine	3/4 inch	100
	3/8 inch	75-100

The contractor may propose gradation bands differing from those shown in the table above. The proposal shall be submitted to the Engineer prior to the start of RAP processing. If approved, the required gradation bands will be adjusted accordingly.

RAP shall be stockpiled so that segregation is minimized. When two RAP stockpiles are used, acceptable methods to prevent intermingling of stockpiles shall be provided.

The Engineer reserves the right to reject obviously defective salvaged material or salvaged material that is not representative of the material used in the mix design.

417-3.05 Warm Mix Asphalt Technologies:

Warm Mix Asphalt (WMA) technologies include plant water foaming processes, mineral additives, and chemical additives. WMA technologies must be approved prior to their use in accordance with Materials Policy and Procedure Directive No. 23, "Requirements for the Use of Warm Mix Asphalt (WMA) Technologies in Asphaltic Concrete".

417-4 Mix Design:

Utilizing mineral aggregate and RAP which has been crushed, processed, separated, and stockpiled, a mix design shall be formulated and submitted by the contractor to the Engineer. The mineral aggregate and RAP samples used for mix design purposes shall be representative of materials to be used during production.

The mix design shall be based on the mix design criteria and other requirements hereinbefore specified, utilizing asphalt cement and mineral admixture of the type and from the sources proposed for use in the production of asphaltic concrete.

The mix design shall be prepared by or under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. The mix design engineer shall meet the requirements given in ADOT Materials Policy and Procedure Directive No. 4, "Asphaltic Concrete Mix Design Proposals and Submittals". The mix design shall be provided in a format that clearly indicates all the mix design requirements and shall be sealed, signed, and dated by the mix design engineer.

The mix design shall be prepared by a mix design laboratory that has met the requirements of ADOT Materials Policy and Procedure Directive No. 19, "ADOT System for the Evaluation of Testing Laboratories".

The contractor may propose the use of a mix design that has been developed for a previous project. The proposed mix design shall meet the requirements of these specifications. The contractor shall provide evidence that the type and source of bituminous material, the type of mineral admixture, and the source and methods of producing virgin mineral aggregate and RAP have not changed since the formulation of the previous mix design. The contractor shall also provide current test results for all specified characteristics of the mineral aggregate and RAP proposed for use. The Engineer will determine if the previously used mix design is suitable for the intended use and if the previous use of the mix design was satisfactory to the Department. The Engineer will either approve or disapprove the proposed mix design. Should the Engineer disapprove the use of the previously used mix design, the contractor shall prepare and submit a new mix design proposal in accordance with the requirements of these specifications.

A previously used mix design older than two years from the date it was formulated, sealed, signed, and dated shall not be allowed for use. Once approved for use on a project, a mix design may be used for the duration of that project.

The mix design shall contain as a minimum:

- (1) The name and address of the testing organization and the person responsible for the mix design testing.
- (2) The specific location(s) of the source(s) of mineral aggregate.
- (3) The supplier, refinery, type of asphalt cement and any modifiers including polymers. The source and type of mineral admixture. The percentage of asphalt cement and mineral admixture to be used.
- (4) The anticipated mineral aggregate gradation in each stockpile.
- (5) Mix design gradation and mix test results from all trial gradations. The mix design shall contain the mineral aggregate gradation, and also the gradation with mineral admixture.
- (6) The results of all testing, determinations, etc., such as: specific gravity of each component, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, flat and elongated particles, uncompacted void

content, percent carbonates (if required), immersion compression results (Index of Retained Strength, wet and dry strengths), asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density.

- (7) Viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used.

When RAP is used in the mixture, the following additional information shall be included in the mix design:

- (1) The specific location(s) of the source(s) of RAP.
- (2) The anticipated RAP gradation, RAP aggregate gradation, and RAP binder content in each stockpile.
- (3) If greater than 15 percent RAP binder is used in the mixture, the results of all tests on the recovered RAP binder, as well as all tests on the blend of virgin binder and recovered RAP binder.
- (4) The percent RAP binder, virgin binder, and total binder in the mixture.
- (5) The composite gradation of virgin and RAP aggregates, with and without mineral admixture. The composite gradation of the virgin aggregate and RAP, with and without mineral admixture.
- (6) The results of all testing, determinations, etc., for the RAP, virgin aggregate, RAP aggregate, and composite of virgin and RAP aggregates as required, such as: specific gravity, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, flat and elongated particles, uncompacted void content, and percent carbonates.
- (7) The viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges for the blended binder, if greater than 15 percent RAP binder is used in the mixture, as well as the actual laboratory mixing and compaction temperatures used.

When Warm Mix Asphalt (WMA) technologies are used in the mixture, the additional mix design requirements specified in Materials Policy and Procedure Directive No. 23, "Requirements for the Use of Warm Mix Asphalt (WMA) Technologies in Asphaltic Concrete", shall also be included in the mix design.

Test results used in the formulation of the mix design shall be from testing performed no earlier than 45 days prior to the date the mix design is signed by the mix design engineer. Historical abrasion values may be supplied on sources provided the testing was conducted within the past two years.

The mix design shall be submitted to the Engineer under a cover letter signed by an authorized representative of the contractor.

A copy of the mix design and representative samples of the materials used in the mix design shall be submitted to the Engineer for calibration of the ignition furnace, and for the determination of the sand equivalent, fractured coarse aggregate particles, and uncompacted void content. Approximately 300 pounds of virgin mineral aggregate (proportional to the mix design gradation), three gallons of asphalt cement, and one gallon of mineral admixture shall be submitted. When RAP is used, a minimum of 40 pounds of representative RAP material and a minimum of 10 pounds of solvent-extracted RAP aggregate, per AASHTO T 164, Method A, shall be submitted. If RAP is fractionated, the RAP and RAP aggregate from each stockpile shall be kept separate. The Engineer shall witness the sampling of the virgin mineral aggregate and RAP. The mix design and samples shall be submitted to the Engineer at least five working days prior to the start of asphaltic concrete production.

The sand equivalent, fractured coarse aggregate particles, and uncompacted void content shall meet the requirements specified in Subsection 417-3.01. Additional testing of the uncrushed and crushed fine aggregate for uncompacted void content will be required if the method of producing either fine aggregate is modified.

If the mineral aggregate fails to meet the requirements specified herein, asphaltic concrete production shall not commence, and the contractor shall either submit a revised mix design which is representative of the materials produced or correct the deficiencies in the aggregate stockpiles.

The Engineer will review the mix design to assure that it contains all required information. If it does not, it will be returned within two working days of receipt of all samples and mix design information for further action and resubmission by the contractor.

If the contractor elects to change its source(s) of mineral aggregate or RAP, or adds or deletes the use of a stockpile(s) regardless of source, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

If changes are made in the source or type of bituminous material, or the type of mineral admixture, the contractor shall provide verification testing results. Verification testing shall be performed at the original mix design asphalt content using the original mineral aggregate and RAP (if used), the proposed bituminous material, and/or the proposed mineral admixture. Three specimens shall be fabricated and tested for bulk density, maximum theoretical density, and effective voids. The percent effective voids must be within ± 0.2 of the percent effective voids in the original design and also be within the current effective voids mix design specification limits. Verification testing results shall not replace target values shown in the original mix design. All target values from the original design shall be used in future production with the exception of any self-directed target value changes that are requested. The verification process does not ensure that the contractor can meet the target values during production.

In addition to the verification testing specified above, verification testing for immersion compression may also be required. If there is a change in the type of mineral admixture, immersion compression testing is required. If there is a change in the source or type of bituminous material, immersion compression testing is required if the Index of Retained Strength of the original mix design is less than ten percentage points greater than the specified minimum, or if the Wet Strength is less than 100 psi greater than the specified minimum.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing and acknowledged by the Engineer prior to start of production for a lot. Self-directed target changes shall meet contract requirements for mix design criteria and grading limits.

MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (sieve size): 3/8 inch No. 8 No. 40 No. 200	$\pm 4\%$ from mix design target value $\pm 4\%$ from mix design target value $\pm 2\%$ from mix design target value $\pm 0.5\%$ from mix design target value
Asphalt Cement Content	$\pm 0.2\%$ from mix design target value
Effective Voids	None

The contractor may propose target changes to the approved mix design for the Engineer's approval. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and grading limits. For acceptance purposes, target changes will not be retroactive.

In no case shall the approval of mix design changes relieve the contractor of the responsibility for the results obtained by the use of such approved changes.

Should a mix design prove unsatisfactory to the contractor during production, the contractor shall furnish the Engineer with a revised mix design. For acceptance purposes, the revised mix design will not be retroactive.

The contractor shall not change its methods of crushing, screening, washing, or stockpiling from those used during production of material used for mix design purposes without approval of the Engineer or without preparing a new mix design.

417-5 Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C). At the weekly meeting, the contractor shall be prepared to explain and discuss how the following processes will be employed.

- (a) Aggregate production, including crusher methods, pit extraction, and washing.

- (b) RAP production, including milling, crushing, screening, and handling methods.
- (c) Stockpile management, including stacking methods, separation technique, plant feed technique, stockpile pad thickness, and segregation prevention.
- (d) Proportioning and plant control, including plant scale calibration, mix temperature control, storing method, and addition of admixture.
- (e) Transporting and placing, including hauling distance and temperature control, segregation and non-uniform placement control, and joint placement and technique.
- (f) Compaction, including types and weight of rollers, establishing and monitoring of roller patterns, and temperature controls.

The contractor shall obtain samples and perform the tests specified in the following table:

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	TEST METHOD	SAMPLING POINT	MINIMUM TESTING FREQUENCY
Virgin Mineral Aggregate			
Gradation	ARIZ 201	Crusher Belt or Stockpile	1 per stockpile per day
Sand Equivalent	AASHTO T 176		1 per 2000 Tons of total virgin aggregate (1)
Fractured Coarse Aggregate Particles	ARIZ 212		
Uncompacted Void Content	ARIZ 247		
Reclaimed Asphalt Pavement			
Gradation, Moisture Content, and Binder Content	ARIZ 428 (Appendix A)	Crusher Belt or Stockpile	1 per stockpile per day
RAP Aggregate			
Gradation	ARIZ 201	Crusher Belt or Stockpile	1 per stockpile per day
Fractured Coarse Aggregate Particles	ARIZ 212		1 per stockpile every other day
Asphaltic Concrete			
Gradation	ARIZ 201 or 427 (428 for RAP mixes)	Cold Feed, Hot Bins, Roadway, or Plant	1 per 1000 Tons

Asphalt Content	ARIZ 421, 427 (428 for RAP mixes), or other approved methods	Roadway or Plant	1 per 1000 Tons
Voids	AASHTO T 312 (2), ARIZ 415, 417, 424	Roadway or Plant	1 per 1000 Tons each day. Maximum of 4 per day.
Compaction	ARIZ 412	Roadway	1 per 300 tons
<p>Notes:</p> <p>(1) Prior to the completion of the mix design, quality control tests on mineral aggregate shall be performed based on the anticipated percent use of each stockpile. Samples taken from individual stockpiles may be composited prior to performing the required tests, or testing may be performed on material from each stockpile and the composite test result for each required test determined mathematically.</p> <p>(2) Except compaction shall be performed to the number of gyrations specified for N-max in Note 4 of Table 417-1 and the density of the compacted specimens shall be calculated for N-design gyrations.</p>			

417-6 Construction Requirements:

The contractor shall be responsible for the proportioning of all materials, for the hauling, placing, loading, spreading, and finishing of asphaltic concrete, and for the applying of bituminous material, such as tack coats, prime coats, and provisional seals, all in accordance with the appropriate portions of the specifications.

The asphaltic concrete hot plant shall conform to the requirements of Section 403 of the Specifications.

During production, the percent RAP aggregate and percent RAP binder shall not exceed the maximum allowed in Subsections 417-3.01(C), 417-3.03(C), and 417-3.04. In addition, the percent RAP material shall be maintained to within plus 2 percent and minus 5 percent of the mix design value(s). When two RAP stockpiles are used, this tolerance shall apply to the total percent RAP material in the mixture, as well as the percent RAP material from each stockpile.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the drier shall not exceed 325 °F unless a higher temperature is recommended in writing by the asphalt binder supplier and approved by the Engineer.

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

Self-propelled paving machines shall spread the mixture within the specified tolerances, without segregation or tearing, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which shall distribute the mixture uniformly in front of adjustable screeds.

Pavers shall be equipped with a screed for the full width being paved, heated if necessary, and capable of spreading and finishing all courses of asphaltic concrete.

Pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope.

Failure of the control system to function properly shall be cause for the suspension of the placing of asphaltic concrete.

The base or subgrade upon which asphaltic concrete is to be placed shall be prepared and maintained in a firm condition until asphaltic concrete is placed. It shall not be frozen or excessively wet.

At any time, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors and other equipment surfaces shall be treated when necessary with a release agent approved by the Engineer in order to prevent the sticking of asphaltic concrete. Release agents which degrade, dissolve, or in any way damage the bituminous material shall not be used. Diesel fuel shall not be used as a release agent.

Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of any immediate underlying course.

When surfacing courses are placed on ten foot or wider shoulders which are to receive rumble strips, the contractor shall place any longitudinal joints approximately one foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the centerline between two adjacent lanes. Joints shall be formed by a slope shoe or hot-lapped, and shall result in an even, uniform surface.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth of the lift and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense

and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

All locations where plate samples are taken from the roadway shall be immediately repaired by the contractor utilizing hot asphaltic concrete. All holes where cores are taken shall be repaired within 48 hours after coring using a material approved by the Engineer. All holes shall be in a dry condition prior to repair. The patching material shall be thoroughly compacted in the holes by the contractor.

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked in accordance with the requirements of Section 404. The cleaning of the surface, the tacking of the surface, and the type of bituminous material used shall be acceptable to the Engineer. The amount of bituminous material used shall be as directed by the Engineer.

A light coat of bituminous material shall be applied to edges or vertical surfaces against which asphaltic concrete is to be placed.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent. The moisture content will be determined in accordance with Arizona Test Method 406.

When Warm Mix Asphalt (WMA) technologies are used, the contractor shall comply with the manufacturer's recommendations for incorporating additives and WMA technologies into the mixture. The contractor shall comply with the manufacturer's recommendations regarding transporting, storage, and delivery of additives and water foaming processes. The contractor shall maintain a copy of the manufacturer's recommendations on file at the asphalt mixing plant and make those recommendations available for reference while using WMA technologies.

417-7 Acceptance:

417-7.01 General:

In addition to the random acceptance samples taken from each lot, the Engineer may sample and reject material which appears to be defective. Such rejected material shall not be used in the work. The results of tests run on rejected material will not be included with the lot acceptance tests.

Acceptance will be on the basis of the following:

- Sand Equivalent
- Fractured Coarse Aggregate Particles
- Uncompacted Void Content
- Material Spread
- Gradation
- Asphalt Cement Content
- Effective Voids
- Compaction
- Smoothness

417-7.02 Sand Equivalent, Fractured Coarse Aggregate Particles, and Uncompacted Void Content of Mineral Aggregate:

During asphaltic concrete production, the Engineer shall obtain and test samples of material for the determination of the sand equivalent, fractured coarse aggregate particles, and uncompacted void content. When RAP is used in the mixture, the sand equivalent and uncompacted void content shall be determined on the composite of virgin aggregates only. Samples shall be obtained from the cold feed belt prior to the addition of mineral admixture, or from the stockpiles when sampling from the cold feed belt is not possible.

When RAP is used in the mixture, the material for determining the fractured coarse aggregate particles shall come from an asphaltic concrete sample taken and tested in accordance with Arizona Test Method 428, as specified in Subsection 417-7.04(A). However, if the Engineer determines that excessive breakdown of the aggregate has occurred due to the use of the ignition furnace, the fractured coarse aggregate particles testing shall be performed on the combination of RAP aggregate, as obtained in accordance with Arizona Test Method 428, and virgin mineral aggregate.

Virgin mineral aggregate will be acceptable for sand equivalent if it meets the minimum requirements specified in Subsection 417-3.01.

The fractured coarse aggregate particles shall meet the minimum requirements specified in Subsection 417-3.01.

The uncompacted void content shall meet the minimum requirements specified in Subsection 417-3.01. Additional testing of the uncrushed and crushed fine aggregate for uncompacted void content will be required if the method of producing either fine aggregate is modified.

If the mineral aggregate fails to meet these requirements, operations shall cease and the contractor shall have the option of submitting a revised mix design conforming to the requirements of Subsection 417-4 or correcting deficiencies in the aggregate stockpiles.

417-7.03 Material Spread:

A spread lot shall be considered to be one-half shift of production. Lots encompassing more than one project shall be separated in accordance with Subsection 417-9(D).

The contractor shall record information pertaining to each spread lot on forms provided by the Engineer. Information shall include the project number, date and period of time that each spread lot was placed, the spread lot number, beginning and ending station, the plans thickness, and tons placed in each lot. Completed spread lot forms shall be signed by the contractor and given to the Engineer at the end of each shift.

The Engineer will calculate the quantity required in each spread lot using the mix design bulk density unless a request is made by the contractor to use a production bulk density. If a request is made to use production bulk density, the first three non-rejected lots following the test lot will be used to determine the average production bulk density. All lots placed prior to establishing the average production bulk density shall be calculated using the mix design bulk density. For each new mix design used on the project, a new production bulk density may be requested by the contractor. In addition, if conditions warrant during asphalt production, the contractor may request establishment of a new average production bulk density. A request All requests to use a production bulk density shall be made in writing and approved by the Engineer prior to use. The same procedure will be used for determining average production bulk density in all cases. Changes to the bulk density for calculating spread quantities will ~~shall~~ not be retroactive.

The calculated quantity required in each spread lot will be compared to the actual quantity placed. A lot will be considered to be acceptable, with a zero pay factor, if the actual quantity placed varies by no more than -2.0 to +5.0 percent from the required quantity.

If the quantity in a lot is found to vary from the required quantity by -2.1 to -12.0 percent, the appropriate pay factor will be determined in accordance with Table 417-3. This pay factor will be utilized in determining the pay adjustment as outlined in Subsection 417-9.

417-7.04 Gradation, Asphalt Cement Content, and Effective Voids:

(A) General:

A mixture properties lot shall be considered to be one shift's production. In the event a shift's production is less than 1200 tons, multiple shifts may be combined to form a lot. When a lot consists of production from more than one shift, the following conditions apply: at least one sample shall be taken each shift, at least one sample shall be taken every 500 tons, and no mix design or target value changes shall be made within the lot. If changes are made in the mix design or target values, new lots will be established.

Four samples of the asphaltic concrete shall be taken for each lot by the contractor, under the observation of the Engineer, at random locations designated by the Engineer. Samples will be taken in accordance with the requirements of Section 2 or 3 of Arizona Test Method 104 and delivered to the Engineer immediately after being taken. The minimum weight of the sample shall be 130 pounds. The Engineer will split the sample and save one-half for 15 days after written notification to the contractor of test results for that lot has been made. The material will be tested by the Engineer for the following properties:

Test Property	Test Method
Asphalt Cement Content	Arizona Test Method 427 (428 for RAP mixes) (See Notes 1 and 2 below)
Gradation	
Gyratory Density	AASHTO T 312 (See Note 3 below)
Maximum Theoretical Density	Arizona Test Method 417
Effective Voids	Arizona Test Method 424
<p>Notes:</p> <p>(1) A new calibration of the ignition furnace shall be performed for each mix design, and at any other time the Engineer directs.</p> <p>(2) Ignition furnace results will be corrected for asphalt cement content in accordance with Subsection 417-7.04(B) or (C) as required.</p> <p>(3) Except compaction shall be performed to the number of gyrations specified for N-max in Note 4 of Table 417-1 and the density of the compacted specimens shall be calculated for N-design gyrations.</p>	

Acceptance testing results will be furnished to the contractor within four working days of receipt of samples by the Engineer.

The target values for gradation, asphalt cement content, and effective voids are given in the contractor's mix design. The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each of the measured characteristics are as follows:

Measured Characteristics	Coarse Band 3/4" and 1/2" Mixes		Fine Band 3/4" and 1/2" Mixes	
	LL	UL	LL	UL
Gradation				
3/8" sieve	TV - 8.0	TV + 8.0	TV - 6.0	TV + 6.0
No. 8 sieve	TV - 5.0	TV + 5.0	TV - 6.0	TV + 6.0
No. 40 sieve	TV - 5.0	TV + 5.0	TV - 5.0	TV + 5.0
No. 200 sieve	TV - 2.0	TV + 2.0	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.50	TV + 0.50	TV - 0.50	TV + 0.50
Effective Voids	TV - 2.0	TV + 1.5	TV - 2.0	TV + 1.5
<p>Note: The limits are used in the statistical calculations for Quality Index. Acceptance is controlled by the variability of the produced material and every effort should be made to strive for the center of the applicable Target Value (TV).</p>				

The Engineer will determine the PT for each measured characteristic in accordance with Subsection 417-9(I), and utilizing Table 417-3 will determine the pay factor for each measured characteristic.

In the event the contractor elects to question the mixture property test results, the contractor may request referee testing in accordance with Subsection 417-9(J).

(B) Ignition Furnace Correction for Non-RAP Mixes:

For plants providing asphaltic concrete exclusively for the project, the difference between the asphalt cement content as measured by ignition furnace testing and the actual asphalt cement content shall be determined by the Engineer for each of the first five lots of asphaltic concrete produced for each mix design. If there are less than five lots for the mix design, the total number of available lots shall be used. If approved by the Engineer, a plant may be considered exclusive to the project if an asphalt cement tank is dedicated for the shift of asphaltic concrete production. The determination of the actual asphalt cement content may include weighing of asphalt cement deliveries, invoice quantities, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted materials. If a computerized mass-flow meter is used, documentation of its calibration shall be submitted to the Engineer prior to asphaltic concrete production. At any time during asphaltic concrete production, the Engineer may require that a new calibration of the mass-flow meter be performed. If the average difference exceeds ± 0.10 percent asphalt cement content between the asphalt cement content measured by ignition furnace testing and the actual asphalt cement content, the contractor may request that a correction to the asphalt cement content by ignition furnace testing be made. The contractor must make such a request in writing within two working days after receiving the test results for the fifth lot of asphaltic concrete production. If referee testing is performed on a lot of asphaltic concrete for which a correction, based on the actual asphalt cement content, was made to the asphalt cement content by ignition furnace testing, referee testing shall not apply to the determination of asphalt cement content. The correction, once documented and approved by the Engineer, shall be applied to test results from the beginning of asphaltic concrete production through the remainder of asphaltic concrete production using that mix design; however, a new correction may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances. If the contractor submits a new mix design, a new correction must be established and applied as specified above. For plants not providing asphaltic concrete exclusively for this project, no correction will be made to asphalt cement content values measured by ignition furnace testing.

(C) Ignition Furnace Correction for Mixes Containing RAP:

For mixes containing RAP, an asphalt cement tank shall be dedicated to the project for each shift of asphaltic concrete production. The difference between the asphalt cement content as measured by ignition furnace testing and the actual asphalt cement content shall be determined by the Engineer for each of the first five lots of asphaltic concrete produced for each mix design. If there are less than five lots for the mix design, the total number of available lots shall be used. The actual asphalt cement content shall be determined by adding the virgin asphalt cement content to the RAP binder content determined in Subsection 417-7.04(D), both expressed as a percent of the total mix. The determination of the virgin asphalt cement content may include weighing of asphalt cement deliveries, invoice quantities, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted

materials. If a computerized mass-flow meter is used, documentation of its calibration shall be submitted to the Engineer prior to asphaltic concrete production. At any time during asphaltic concrete production, the Engineer may require that a new calibration of the mass-flow meter be performed. If the average difference exceeds ± 0.10 percent asphalt cement content between the asphalt cement content measured by ignition furnace testing and the actual asphalt cement content, a correction to the asphalt cement content by ignition furnace testing shall be made. The correction shall be applied to test results from the beginning of asphaltic concrete production through the remainder of asphaltic concrete production using that mix design; however, a new correction may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances. If the contractor submits a new mix design, a new correction must be established and applied as specified above. Referee testing shall not apply to the determination of asphalt cement content for asphaltic concrete containing RAP.

(D) RAP Binder Content:

(1) General:

During asphaltic concrete production, the Engineer shall obtain and test samples of the RAP material to determine the RAP binder content in each stockpile at a minimum frequency of one sample per lot. The RAP will be tested by the Engineer for asphalt binder content in accordance with Arizona Test Method 428. When more than one RAP sample is tested for a given lot and stockpile, the average of the results shall be used.

(2) RAP Binder Content Correction Factor:

A RAP binder correction factor shall be determined for each RAP stockpile used in the mixture.

At the start of asphaltic concrete production, the first two samples of RAP material from each stockpile will be split and tested for asphalt binder content; one split is tested in accordance with Arizona Test Method 428 (ignition furnace) and the other split is tested in accordance with AASHTO T 164 (solvent extraction). A RAP binder correction factor will be determined by subtracting the average ignition furnace result from the average solvent extraction result. The appropriate correction factor shall be added to each asphalt binder test result determined on the material from each RAP stockpile in accordance with Arizona Test Method 428 to determine the RAP binder content. At the discretion of the Engineer, the correction factor may be determined prior to the start of asphaltic concrete production provided representative RAP samples are available. A new correction factor may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances.

417-7.05 Compaction:

(A) Courses 1-1/2 Inches or Less in Nominal Thickness:

(1) General Requirements:

Asphaltic concrete shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 degrees F and the ambient temperature at the beginning of placement is at least 65 degrees F and rising. The placement shall be stopped when the ambient temperature is 70 degrees F or less and falling.

When Warm Mix Asphalt (WMA) technologies are not used in the mixture, asphaltic concrete immediately behind the laydown machine shall be a minimum of 275 degrees F.

When Warm Mix Asphalt (WMA) technologies are used in the mixture, the recommended temperature range for compaction during production shall be shown on the mix design and shall be approved by the Engineer.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

(2) Equipment:

Compacting and smoothing shall be accomplished by the use of self-propelled equipment. Compactors shall be pneumatic tired and/or steel wheel.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Steel wheel compactors shall weigh not less than eight tons.

Pneumatic tired compactors shall be the oscillating type with at least seven pneumatic tires of equal size and diameter. Wobble-wheel compactors will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be capable of being inflated to 90 pounds per square inch and maintained so that the air pressure will not vary more than 5 pounds per square inch from the designated pressure. Pneumatic tired compactors shall be constructed so that the total weight of the compactor will be varied to produce an operating weight per tire of not less than 5,000 pounds. Pneumatic tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

(3) Rolling Method Procedure:

Compaction shall consist of an established sequence of coverage using specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used, and the number of coverages required shall be as follows:

	Type of Compactor	No. of
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Rolling Sequence			Coverages	
	Option No. 1	Option No. 2	Option No. 1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2 - 4*
Finish	Static Steel	Static Steel	1 - 3	1 - 3
* Based on the roller pattern which exhibits the best performance.				

The Engineer shall select the option for compaction and, when pneumatic tired compactors are used, will designate the tire pressure.

One pneumatic tired roller shall be furnished for each 300 tons of asphaltic concrete per hour.

Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F.

Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 degrees F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified, and with the number of coverages of the compactors as specified.

(B) Courses Greater than 1-1/2 Inches in Nominal Thickness:

Compaction control shall be the responsibility of the contractor. The number and types of rollers shall be the contractor's responsibility and shall be sufficient to meet these requirements.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

A compaction lot shall be identical to the mixture properties lot described in Subsection 417-7.04. Lots encompassing more than one project shall be separated in accordance with Subsection 417-9 (D). Each lot shall be tested for acceptance.

Twenty cores shall be taken for each lot by the contractor, under the observation of the Engineer. The Engineer will designate ten random locations within the lot, and the contractor shall take two cores at each location; however, if more than one shift constitutes a lot, two cores shall be taken from a minimum of two random locations each shift, or as directed by the Engineer. The Engineer will save one core from each location for 15 days after written notification to the contractor of test results for the lot has been made. Randomly selected locations will be determined to the nearest one-half foot in the transverse direction and to the nearest foot in the longitudinal direction of the pavement course; however, the outside one foot of the unconfined pavement course will be excluded from testing as shown in ADOT Materials Policy and Procedure Directive (P.P.D.) No. 18,

“Determining Sample Times and Locations for End Product Asphaltic Concrete”. P.P.D. No. 18 also addresses areas to be excluded relative to longitudinal joints. Areas excluded from testing will be compacted in accordance with Subsection 417-7.05(A). Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104. Cores shall be a minimum of four inches in diameter and shall be taken not later than two working days after placement of the asphaltic concrete. The cores shall be delivered to the Engineer immediately upon being taken. The bulk density of each core will be determined by the Engineer in accordance with the requirements of Arizona Test Method 415. The test results will be furnished to the contractor within four working days of receipt of cores by the Engineer. In areas where more than one lift is placed in the same lot, coring shall be accomplished through the full depth of the lifts after the final lift is placed, and the compaction density shall be based on the full depth of the lifts.

The target value for compaction shall be 7.0 percent in-place air voids. In-place air voids shall be determined in accordance with Arizona Test Method 424. The maximum theoretical density used in the determination of air voids will be the average of the four maximum theoretical densities determined for the lot in Subsection 417-7.04.

The Upper Limit (UL) is 9.0 percent in-place air voids and the Lower Limit (LL) is 3.5 percent in-place air voids. The Engineer will determine the PT for compaction in accordance with Subsection 417-9(I), and utilizing Table 417-3 will determine the compaction pay factor.

In the event the contractor elects to question the core test results, the contractor may request referee testing in accordance with Subsection 417-9(J).

417-7.06 Smoothness and Surface Tolerances:

Asphaltic concrete shall be compacted as required, smooth and true to the required lines, grades, and dimensions.

The Special Provisions may require the smoothness of the final pavement surface to be tested in accordance with Subsection 109.13.

Regardless of whether testing in accordance with Subsection 109.13 is specified or not, the following requirements shall be met:

- (1) The surface of the final lift of asphaltic concrete placed under this section of the specifications shall be tested and shall not vary by more than 1/8 inch from the lower edge of a ten-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints.
- (2) The surface of any lift of asphaltic concrete placed under this section of the specifications, other than the final lift, shall be tested and shall not vary by more than 1/4 inch from the lower edge of a ten-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints.

- (3) All deviations exceeding the specified tolerances above shall be corrected by the contractor, to the satisfaction of the Engineer.

417-8 Method of Measurement:

(A) Asphaltic Concrete:

Asphaltic concrete will be measured by the ton for the asphaltic concrete actually used, which will include the weight of mineral aggregate, asphalt cement, and mineral admixture. Measurement will include any quantity used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

(B) Asphalt Cement:

(1) Non-RAP Mixes:

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsections 417-7.04(A) and (B) for each lot of asphaltic concrete accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. If the contractor has requested referee testing, the average asphalt cement content will come from the independent testing laboratory results, unless a correction, based on the actual asphalt cement content, was made to the ignition furnace test value as allowed in Subsection 417-7.04(B). If a correction, based on the actual asphalt cement content, was made to the ignition furnace test value, the average asphalt cement content determined from the Department's acceptance testing will be used. At the discretion of the Engineer, asphalt cement may be measured by invoice quantities, adjusted as necessary for waste. Waste generated from startup of the asphalt plant will be considered to have a binder content of 3.0 percent. In no case shall the measured amount of asphalt cement for payment be greater than the total of the invoice quantities, adjusted for waste.

(2) Mixes Containing RAP:

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsections 417-7.04(A) and (C) for each lot of asphaltic concrete accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. At the discretion of the Engineer, asphalt cement may be measured by adding invoice quantities to the RAP binder used, adjusted as necessary for waste. RAP binder used shall be determined by multiplying the RAP binder content determined in Subsection 417-7.04(D) by the number of tons of dry RAP material used in that lot. Waste generated from startup of the asphalt plant will be considered to have a binder content of 3.0 percent. In no case shall the measured amount of asphalt cement for payment be greater than the total of the invoice quantities plus the RAP binder as determined above, adjusted for waste.

(C) Mineral Admixture:

Mineral admixture will be measured by the ton for the mineral admixture actually used in accordance with Subsection 403-2.

417-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price adjusted by the appropriate pay factors as hereinafter provided.

When Warm Mix Asphalt (WMA) technologies are used in the mixture, no separate payment will be made for WMA additives or technologies, necessary hot plant modifications, or other associated costs.

For the purpose of determining acceptability and appropriate pay factors, each unit of asphaltic concrete will be included in three separate lots: a "spread lot," a "mixture properties lot," and a "compaction lot." The total unit price for any unit of accepted asphaltic concrete will be the contract unit price, adjusted by the applicable spread lot pay factor, mixture properties lot pay factor, and compaction lot pay factor.

The contractor may request to place the first lot of each mix type as a test strip. Requests to place a test strip shall be made in writing and acknowledged by the Engineer prior to start of production. A test strip shall be limited to 1,000 tons and may only be placed on shoulders, ramps, cross roads, or other areas approved by the Engineer. A test strip shall be excluded from the mixture properties lot pay factor and the compaction lot pay factor; however, all other provisions of Subsection 417-9 shall still apply to such areas.

The Engineer may exclude asphaltic concrete from the spread lot and from the spread lot pay factor calculations if the Engineer determines that the proposed use of the material or the existing surface conditions are not conducive to the use of spread lots.

The Engineer may exclude certain locations from the mixture properties lot and/or the compaction lot and from the random sampling used in determining the mixture properties lot pay factor and/or the compaction lot pay factor should the Engineer determine that the location of the work precludes normal construction operations.

(A) Spread Lot Pay Factor:

The spread lot pay factor will be determined in accordance with Subsection 417-7.03. If the quantity in a spread lot is found to vary by more than + 5.0 percent from the required quantity, no payment will be made for the material which exceeds + 5.0 percent, including asphalt cement and mineral admixture. If the quantity is found to vary by more than - 12.0 percent from the required quantity, the spread lot will be rejected.

(B) Mixture Properties Lot Pay Factor:

The mixture properties lot pay factor shall be determined in accordance with the following procedure:

- (1) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids shall be determined as set forth in Subsection 417-7.04.
- (2) A single pay factor shall be determined for Gradation and Asphalt Cement Content. That pay factor shall be the lowest pay factor for the individual measured characteristics for Gradation and Asphalt Cement Content.
- (3) If no individual PT value in (1) above is less than 50, the mixture properties lot pay factor shall be the sum of the pay factor determined in (2) above and the Effective Voids pay factor. The negative pay factor for mixture properties shall not exceed \$3.00 per ton. If any individual PT value is less than 50, the lot is in reject and the provisions in Subsection 417-9(E) shall apply.

(C) Compaction Lot Pay Factor:

The compaction lot pay factor shall be determined as set forth in Subsection 417-7.05(B).

(D) Determination of Lot Pay Factors on Contracts Involving Multiple Projects:

When more than one project is included in a single contract, placement during a shift or half shift of production may encompass more than one project. In such case, the applicable spread lot pay factor, mixture properties lot pay factor, and compaction lot pay factor for each project shall be determined as follows:

- (1) Spread lot pay factors will be determined separately for each project utilizing the procedure set forth in Subsection 417-7.03.
- (2) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids will be determined from the results of the random samples taken and tested in accordance with Subsection 417-7.04, regardless of which project(s) the samples fall within.
- (3) PT values and pay factors for compaction, for those areas subject to Subsection 417-7.05(B), shall be determined from separate sets of core samples for each project utilizing the procedure set forth in that Subsection.
- (4) The mixture properties lot pay factor shall be determined separately for each project in accordance with Subsection 417-9(B), utilizing the individual pay factors determined in (2) above.
- (5) The compaction lot pay factor shall be determined separately for each project in accordance with Subsection 417-9(C), utilizing the pay factor determined in (3) above.

(E) Acceptability:

Asphaltic concrete included in any mixture properties lot possessing an individual PT value lower than 50 for Gradation, Asphalt Cement Content, or Effective Voids will be rejected. Asphaltic concrete included in any compaction lot possessing a PT value lower than 50 will be rejected.

Within 15 days after receiving notice that a spread lot, mixture properties lot, or compaction lot of asphaltic concrete has been rejected by the Engineer, the contractor may submit a written proposal to accept the material in place at the applicable maximum negative pay factor(s). Maximum negative pay factors are defined as a minus \$1.00 per ton for spread lots, minus \$5.00 per ton for compaction lots, minus \$3.00 per ton for mixture properties lots in reject for gradation only, minus \$5.00 per ton for mixture properties lots in reject for asphalt cement content and/or effective voids only, and minus \$5.00 per ton for mixture properties lots in reject for asphalt cement content and/or effective voids and also gradation. Positive mixture properties lot pay factors become zero when the compaction lot is in reject and the material is allowed to be left in place. In addition, for any mixture properties lot that is in reject due to asphalt cement content but allowed to remain in place, payment shall not be made for asphalt cement quantities in excess of the upper limit (UL) as determined in Subsection 417-7.04(A).

The proposal shall contain an engineering analysis of the anticipated performance of the asphaltic concrete if left in place. The engineering analysis shall also detail any proposed corrective action, and the anticipated effect of such corrective action on the performance. The engineering analysis shall be performed by an independent professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected mixture properties lot or a rejected compaction lot is submitted for referee testing by the contractor, the 15 days allowed to prepare an engineering analysis will begin upon notification of referee test results.

Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is not accepted, the asphaltic concrete shall be removed at no additional cost to the Department and replaced with asphaltic concrete meeting the requirements of these specifications. If the proposal is accepted, the asphaltic concrete shall remain in place at the applicable maximum negative pay factor(s), and any necessary corrective action shall be performed at no additional cost to the Department.

The Department reserves the right to suspend the work should any of the following conditions occur:

- (1) The occurrence of two or more rejected lots within any ten consecutive production lots.
- (2) The occurrence of three consecutive negative mixture properties lot pay factors or three consecutive negative compaction lot pay factors.
- (3) The occurrence of five or more pay factors that are negative either for a mixture properties lot or for a compaction lot within any ten consecutive production lots.

If the Department elects to suspend the work for any of these conditions, the contractor shall either submit a revised mix design in accordance with Subsection 417-4, or submit for the Engineer's approval a written engineering analysis. The engineering analysis shall detail the course of action necessary to correct deficiencies in the contractor's present production methods such that further production can be accomplished without excessive amounts of asphaltic concrete in penalty or rejection. If approved by the Engineer, the revised mix design or the course of action proposed in the engineering analysis, shall be implemented and the work may continue. Costs or delays due to the provisions of this subsection are not compensable.

(F) Asphalt Cement:

(1) Non-RAP Mixes:

Payment for asphalt cement will be made by the ton. Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01.

(2) Mixes Containing RAP:

When RAP is used in the mixture, payment for asphalt cement will be made by the ton for the total asphalt cement as determined in Subsection 417-8(B)(2). Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01 for the virgin binder only.

(G) Mineral Admixture:

Mineral admixture will be paid for at the predetermined price established in the Bidding Schedule.

(H) Smoothness:

When required in the Special Provisions, payment for smoothness shall be made in accordance with the requirements of Subsection 109.13.

(I) Statistical Acceptance:

The "Total Percentage of Lot Within UL and LL (PT)" shall be determined in accordance with Subsection 109.11 of the Specifications.

Pay Factors (PF) shall be determined by entering Table 417-3 with PT.

TABLE 417-3 PAY FACTORS					
Material Spread		Mixture Properties and Compaction			
Negative Variance %	Pay Factor (Dollars per Ton)	PT	Pay Factors(Dollars per Ton)		
			Gradation and Asphalt	Effective Voids	Compaction

			Cement Content		
2.1 - 3.0	- 0.10	100	0.00	+ 2.00	+ 2.00
3.1 - 4.0	- 0.20	95 - 99	0.00	+ 0.50	+ 0.50
4.1 - 5.0	- 0.30	90 - 94	0.00	0.00	0.00
5.1 - 6.0	- 0.40	85 - 89	0.00	- 0.25	- 0.25
6.1 - 7.0	- 0.50	80 - 84	- 0.25	- 0.50	- 0.50
7.1 - 8.0	- 0.60	75 - 79	- 0.50	- 0.75	- 0.75
8.1 - 9.0	- 0.70	70 - 74	- 0.75	- 1.00	- 1.00
9.1 - 10.0	- 0.80	65 - 69	- 1.00	- 1.25	- 1.25
10.1 - 11.0	- 0.90	60 - 64	- 1.50	- 1.50	- 1.75
11.1 - 12.0	- 1.00	55 - 59	- 2.00	- 2.00	- 2.25
More than 12.0	Reject	50 - 54	- 2.50	- 2.50	- 3.00
See Subsections 417-9 (A) and (E)		Less than 50	Reject-See Subsection 417-9 (E)		

(J) Referee Testing:

(1) Referee Testing Performed for Mixture Properties Only:

Within 15 days after written notification to the contractor of test results for a particular mixture properties lot, the contractor may make a written request for referee testing. The referee testing shall be performed by an independent approved laboratory designated by the Department. The testing of the samples will be performed by the independent testing laboratory without knowledge of the specific project conditions such as the identity of the contractor or mix design laboratory, the test results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for the following properties:

Test Property	Test Method
Asphalt Cement Content (See Note 1 below)	Arizona Test Method 427 (428 for RAP mixes)
Gradation	
Gyratory Density	AASHTO T 312 (See Note 2 below)
Maximum Theoretical Density	Arizona Test Method 417
Effective Voids	Arizona Test Method 424

Notes:

- (1) If a correction to the asphalt cement content by ignition furnace testing is made in accordance with Subsection 417-7.04(B), or if RAP is used in the mixture, the asphalt cement content shall not be subject to referee testing.
- (2) Except compaction shall be performed to the number of gyrations specified for N-max in Note 4 of Table 417-1 and the density of the compacted specimens shall be calculated for N-design gyrations.

The results of the referee testing will be binding on both the contractor and the Department.

Using the referee testing results, the Engineer will determine new PT's for all characteristics, with the exception of asphalt cement content if a correction to the ignition furnace value was made as specified in Subsection 417-7.04(B), or if RAP is used in the mixture.

When referee testing is performed on a mixture properties lot, the referee test result for the average maximum theoretical density will be used to determine a new PT for compaction.

The Department will pay for the referee testing; however, if the combined pay factor of the lot (Mixture Properties plus Compaction) does not improve or is reduced, or if either the mixture properties lot or compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties of that particular lot.

(2) Referee Testing Performed for Compaction Only:

Within 15 days after written notification to the contractor of test results for a particular compaction lot, the contractor may make a written request for referee testing. The bulk density of each of the cores previously saved will be determined in accordance with the requirements of Arizona Test Method 415 by an independent testing laboratory designated by the Department. The testing of the cores will be performed by the independent testing laboratory without knowledge of the specific project conditions, such as the identity of the contractor or mix design laboratory, or the test results by the Department. The percent air voids will be determined in accordance with Arizona Test Method 424. The maximum theoretical density used in the determination of air voids will be the average of the four maximum theoretical densities determined for the lot in Subsection 417-7.04.

The results of the referee testing will be binding on both the contractor and the Department.

When referee testing is performed on a compaction lot, the Engineer will determine a new PT for compaction using the referee testing results.

The Department will pay for the referee testing; however, if the pay factor of the compaction lot does not improve or is reduced, or the compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete will be reduced by the amount of the cost of referee testing for the compaction of that particular lot.

(3) Referee Testing Performed for Both Mixture Properties and Compaction:

When referee testing is performed, as described above, for both the mixture properties lot and the compaction lot, the Engineer will use the referee test results to determine new PT's as specified in Subsections 417-9(J)(1) and 417-9(J)(2).

The Department will pay for the referee testing; however, if the combined pay factor of the lot (Mixture Properties plus Compaction) does not improve or is reduced, or if either the mixture properties lot or compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties and compaction of that particular lot.